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Assessment of the NAFO Division 4T southern Gulf of St. Lawrence Atlantic herring (*Clupea harengus*) stocks in 2013

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

The document presents the assessments of the spring spawning and fall spawning Atlantic herring components from the southern Gulf of St. Lawrence, NAFO Div. 4T. The 2013 assessment of the spring spawner component was based on a sequential population analysis calibrated on both the age-disaggregated gillnet catch rate (CPUE) and acoustic survey indices. The stock is considered to be just above the limit reference point. Projections for the fisheries over the next two years show that the probability of an increase in biomass from January 2014 to January 2016 ranged from almost 100% with no catch to 93% with catches of 2,000 t each year. The 2013 assessment of the fall spawner component was based on two sequential population analyses calibrated on an age-disaggregated gillnet catch rate (CPUE) index and an acoustic index for ages 2 and 3. The two assessment models varied in the assumptions about catchabilities in the fixed gear for ages 4 and 5, but neither model was considered superior for assessing stock status and providing catch advice, therefore the results from both models are presented. The 2014 beginning-of-year spawning stock biomass with model 1 is estimated to be about 98,000 t and in the cautious zone for this stock. The 2014 beginning-of-year spawning stock biomass under model 2 is estimated to be 182,800 t and above the upper stock reference (B_{USR}) level of 172,000 t. Risk analysis results of catch options differ between the models. Advice cannot be provided for more than one year (2014) for the fall spawner component because of important and unresolved model uncertainties. A review of the assessment approach is recommended including data inputs and alternate model formulations that could incorporate changes in natural mortality, changes in catchability, and proportionality of indices.

RÉSUMÉ

Ce document présente les évaluations des composantes de reproducteurs de printemps et d'automne du stock de hareng altantique de la Division 4T de l'OPANO du sud du golfe du Saint-Laurent. L'état de la composante des reproducteurs de printemps dans la zone 4T en 2013 a été déterminé en se fondant sur une analyse de population qui incluait à la fois les taux de prises-à-l'âge (PUE) au filet maillant et l'indice du relevé acoustique. On considère que le stock se situe juste au-dessus du point de référence limite. Les prévisions faites sur les deux prochaines années indiquent que la probabilité d'une augmentation de la biomasse entre janvier 2014 et janvier 2016 variait de presque 100 % (aucune prise) à 93 % (prises annuelles de 2 000 t). L'état de la composante des reproducteurs d'automne dans la zone 4T en 2013 a été déterminé en se fondant sur deux analyses de population qui incluaient les taux de prises-à-l'âge (PUE) au filet maillant et l'indice d'abondance du relevé acoustique pour les âges 2 et 3. Les deux modèles d'évaluation sont basés sur deux hypothèses différentes de capturabilité dans les engins fixes pour les âges 4 et 5. Il existe des problèmes de fiabilité avec les deux modèles lorsqu'il s'agit d'évaluer l'état du stock et de fournir des recommandations de captures, par conséquent, les résultats des deux modèles sont présentés. Pour le début de l'année 2014, la biomasse du stock reproducteur (BSR) est estimée à environ 98 000 t selon le modèle 1, ce qui la situe dans la zone de prudence pour ce stock. Elle est estimée à 182 800 t selon le modèle 2, soit au-delà du niveau de référence supérieur du stock (BNRS) de 172 000 t. Les résultats de l'analyse des risques des options de captures diffèrent entre les modèles. Un avis ne peut être fourni pour plus d'une année (2014) pour la composante de reproducteurs d'automne, en raison d'incertitudes importantes non résolues concernant les modèles. Un examen cadre de l'approche d'évaluation est recommandé comprenant l'examen des données entrantes et d'autres formulations de modèles qui pourraient intégrer des changements dans la mortalité naturelle, des changements dans la capturabilité et la proportionnalité des indices.

INTRODUCTION

Atlantic herring (*Clupea harengus*) in the southern Gulf of St. Lawrence (sGSL) is found in the area extending from the north shore of the Gaspe Peninsula to the northern tip of Cape Breton Island, including the Magdalen Islands. Adults overwinter off the north and east coast of Cape Breton in the Northwest Atlantic Fisheries Organization (NAFO) Divisions 4T and 4Vn (Claytor 2001; Simon and Stobo 1983). Studies in the early 1970s indicated that southern Gulf herring also overwintered off the south coast of Newfoundland, but an exploratory fishery in 2006 did not find any concentrations in that area (Wheeler et al. 2006).

Herring is a pelagic species which forms schools particularly during feeding, spawning periods and annual migrations. Eggs are attached to the sea floor and large females can produce up to 360,000 eggs (Messieh 1988). First spawning occurs primarily at age four.

The herring population in the sGSL consists of two components, the spring spawner component (SSC) and the fall spawner component (FSC), with July 1st as a separation date. Spring spawning occurs primarily in April-May but extends into June at depths <10 m. Fall spawning occurs from mid-August to mid-October at depths of 5 to 20 m. The largest spring spawning beds are in coastal waters of the Northumberland Strait and Chaleur Bay. The largest fall spawning beds are in coastal waters off Miscou and Escuminac N.B., North Cape and Cape Bear P.E.I., and Pictou N.S.

GENERAL DESCRIPTION

THE FISHERY

Landings

The sGSL herring is harvested primarily by an inshore gillnet fleet (fixed gear) and a purse seine fleet (mobile gear), both fishing in the NAFO division 4T and in some years Division 4Vn (Fig. 1). The purse seine fleet can consist of five large southern Gulf vessels (> 65 feet). However, some small Gulf seiners (< 65 feet) can also participate in the inshore fishery as part of the gillnet fleet. Unless specifically stated as small seiners, the terms purse seiners or seiners refer to the purse seine fleet with vessels > 65 feet. During the spring and the fall fishing seasons, seiners are prohibited from fishing in several areas set aside exclusively for the gillnet fleet (Claytor et al. 1998).

Both spring and fall spawner components of herring are harvested in these fisheries. The percentage of spring and fall spawner components in the catch varies according to season and gear type. As a result, landings during the spring and fall fisheries must be separated into the appropriate spring and fall spawning groups to determine if the Total Allowable Catch (TAC) for these groups has been attained.

Prior to 1967, sGSL herring were exploited mainly by gillnets and average landings from 1935 to 1966 were 34,000 t. In the mid 1960s, a purse seine fishery was introduced and average landings by both fleets were 166,000 t for the period 1967 to 1972. A global allocation or TAC was introduced in 1972 at 166,000 t, and reduced to 40,000 t in 1973. Separate TACs for the spring and fall spawner components were introduced in 1985.

The TACs are first allotted by fishing season and later attributed to spring or fall spawner component landings based on biological samples taken during the fishery. The spring and the fall fishing season TACs and landings are summarized for 2012 and 2013 in Table 1 and Figure 2.

Most of the 2012-2013 gillnet catches of the spring fishing season occurred in areas 16B and 16E. Most of the 2012-2013 gillnet catches during the fall fishing season came from area 16B (Table 2; Fig. 1). In the spring (Edge) seiner fishery of 2012, 228 tons were caught while 3,204 tons were caught in the spring (Edge) seiner fishery in 2013. The fall 2012-2013 seiner fishery catches were all from unit areas 4Tm and 4Tn of NAFO division 4T (Figs. 1 and 4).

Since 1981, the gillnet fixed gear fleet has accounted for most of the catch of spring and fall spawners (Table 3; Fig. 3). The recent 2009 to 2013 mean proportion of the total catch caught by the gillnet sector was 58% of the spring spawners and 94% of the fall spawners (Table 4).

The 2012 and 2013 TAC for the spring spawner component was 2,000 t. The combined 2012 and 2013 landings of the spring spawner component in both the spring and the fall fisheries were 599 t and 1,703 t, respectively. The TAC for the fall spawner component in 2012 and 2013 was 43,500 t. The combined 2012 and 2013 landings of the fall spawner component in both the spring and fall fisheries were 32,576 t and 34,368 t, respectively (Tables 3 and 4).

SPAWNING GROUP ASSIGNMENT

At present, DFO Gulf Region Science uses three techniques to assign herring samples to either spring (P) or autumn (A) spawning components based on gonad maturity stages (Cleary et al. 1982). These are:

- For immature herring of maturity stages 1 and 2 (juveniles), the season of hatching is based on the size at capture and visual examination of otolith characteristics (Messieh 1972). The spawning component assignment for juvenile herring is its hatching season (Cleary et al. 1982). Juveniles represent a small percentage of commercial catch, but are a higher proportion in the research survey samples.
- Adult herring with ripe or spent gonads (maturity stages 6 and 7) are assigned their maturity stage by macroscopic laboratory examination of the gonads. The fish are assumed to belong to the spawning component of the season in which they were caught. These represent over 90% of the gillnet catches and 75% of the total yearly landings.
- Adult herring with non-ripe gonads (maturity stages 3, 4, 5 and 8) are assigned their maturity stage by using a gonadosomatic index (GSI) based on a discriminant function model. The GSI is based on the length of the fish and its gonad weight (McQuinn 1989). Once the maturity stage is determined by GSI, the spawning component is assigned by using a maturity schedule decision rule (a table cross-referencing maturity stage assigned by GSI and the date of capture to assign a spawning component) (Cleary et al. 1982).

Changes in spawning group assignment

For the month of June, discrepancies in the assignment of spawning components were found between the GSI assignment of maturity stage by using the current maturity schedule decision rule and the laboratory detailed macroscopic observations. In particular, the 2012 and 2013 Cabot Strait Edge seiner fishery samples were not well classified by the GSI decision rule process.

Based on the laboratory macroscopic observations of adult herring from the Edge seiner fishery biological samples, at least 95% of examined gonads were determined to be of maturity stage 3, which would classify them as fall spawners. However the GSI discriminant function reclassifies at least 20% of the maturity stage 3 to a maturity stage 8, with the existing decision rule assigning stage 8 maturity in June as spring spawners.

The appropriate change was made to the decision rules (a table cross-referencing maturity stage assigned by GSI and the date of capture to assign a spawning component) where a stage 8 maturity in June was classified as a fall spawner.

INDUSTRY INPUT

Industry input for the assessment was acquired during Gulf Small Pelagics Advisory Committee meetings and from a gillnetter telephone survey conducted every year between November and February.

The telephone survey has been conducted yearly since 1986 to collect information on the gillnet fishery and opinions on abundance trends. The southern Gulf was divided into eight areas corresponding to the areas where the major fisheries occur (Fig. 5). Active commercial licence holders were asked a series of questions concerning the number and size of nets they used, the frequency of fishing and how the abundance in the current year compared to the previous year and the medium-term trend. Some information on net data from the telephone survey was used to determine fishing effort. Methods used to conduct the telephone survey were described in LeBlanc and LeBlanc (1996).

By using the gillnetter opinions on the current year's abundance compared to the previous year, an index of opinion on the abundance was calculated for each area as well as an overall index for all areas combined.

For the 2012 gillnetter telephone survey, 222 candidates were randomly selected out of approximately 710 active commercial licences in both seasons combined. Of these 222 candidates, 180 responded to the questionnaire. Among those who responded to the 2012 telephone survey were 27 spring gillnetters and 153 fall gillnetters (Tables 5 and 6; Fig. 5).

For the 2013 gillnetter telephone survey, 201 candidates were randomly selected out of approximately 713 active commercial licences in both seasons combined. Of these 201 candidates, 188 responded to the questionnaire. Among those who responded to the 2013 telephone survey were 28 spring gillnetters and 160 fall gillnetters (Tables 5 and 6; Fig. 5).

Area fleet projects during the fall gillnet fishery combine the collection of acoustic data during commercial fishing and the sampling of variable mesh gillnets (Claytor and Allard 2001). The goal of these projects is to develop a time series of local abundance indices. Sampling of size and age composition was conducted with multiple mesh size experimental nets in addition to the regular commercial nets. In 2012 and 2013, five fall gillnetter boats participated and data analysis is ongoing.

FISHING EFFORT

Fishing effort was calculated as the average number of gillnets deployed by season and area for the entire southern Gulf since 1978. From 1978 to 1985, the average number of nets used was collected by questionnaires done on wharves and by mail (Clay and Chouinard 1986). Since 1986, the effort measurement used to calculate the abundance indices based on gillnet fishery catch rates is the number of standard gillnets used in the spring and fall fisheries as estimated from the telephone survey (LeBlanc and LeBlanc 1996) and, since 2005, from dockside observer data, where available. A standard net is 15 fathoms (27.4 m) in length (Table 7).

The percent of gillnet fishing days with no catch has been recorded for the past eight years (Table 8). For the spring fishing season, the percentage of days with no catch is higher than the fall, except for 2011. This information was not recorded in years prior to 2006 and is not part of the effort data used to calculate catch per unit effort.

The depth of gillnets, in meshes, used by season and area was examined in the 2012 and 2013 telephone survey to verify changes that could affect fishing effort. In the spring 2012 and 2013 gillnet fishery, the mean net depth ranged from 44 to 100 meshes deep depending on area. In the fall 2012 and 2013 gillnet fishery, the mean net depth ranged from 80 to 118 meshes deep, depending on area (Table 9). The gillnet depth has been fairly constant in recent years in most areas.

The telephone survey data on number and length of gillnets used in 2012 and 2013 was compared to gillnet data collected by the dockside monitoring program (DMP), where these were available (Table 9). In general, the two sets of data give similar results in most areas where there were a sufficient number of respondents. The gillnet data chosen for the abundance index were those with the greatest number of records.

CATCH AND WEIGHT-AT-AGE MATRICES

Separate catch-at-age and weight-at-age matrices were calculated for all 4T herring spring and fall spawner components, including those caught by purse seiners. These were derived using age-length keys and length-weight relationships for each principal fishing area and season. In some cases, fishing activity within an area differed through the season and separate keys and relationships were developed for those cases. When fewer than 30 fish were sampled for detailed analysis, the overall length-weight relationship and age-length key most similar and adjacent to in gear, geography, and time were used to estimate the catch-at-age.

AGE READING CONSISTENCY TEST

Starting in 2010, otolith age reading was done from digital photographs and read on a computer screen, as compared to previous aging done with a stereomicroscope. This new method enhanced the picture quality and made age reading more accurate. Also, a new reader was trained in 2010 to become the primary reader who aged the otoliths from 2013.

Yearly age reading consistency tests are done in order to evaluate and ensure the consistency of age reading over time. A sub-sample of pairs of herring otoliths from years 1993, 1994, 1996 and 2003 was re-aged, and the new ages were compared to the reference ages. This test was conducted after the completion of age reading on most of the 2013 samples.

Otolith samples were randomly selected for age-groups 1 to 11+ and from years between 1993 and 2003, gear types used and type of sample (commercial and research). In total, a final set of over 200 otoliths was used. Results are presented for the primary reader. For this assessment, the ages of the primary reader are used for 2012 and 2013.

The results for the primary reader show an overall agreement of 93% and a coefficient of variation (CV) of 1.9%. (Table 10; Fig. 6). The CV is considered to be a more robust measure of the precision of age determination (Campana et al. 1995). From the reading bias plot, there was no bias present, and age determination is more variable for older (9+) herring (Table 10; Fig. 6).

GILLNET FISHERY CATCH RATES

Gillnet catch and effort data are used to construct abundance indices for both the spring and fall spawning components of 4T herring. The gillnet fisheries take place on the spawning grounds and generally account for approximately 65% of the spring spawner catch, and more than 90% of the fall spawner catch. The remaining portion of the catch of both components is taken by the purse seine fleet fishing primarily on mixed aggregations prior to and during the migration out of the Gulf in the fall.

The catch data used to calculate the spring catch per unit of effort (CPUE) series consisted of data from a dockside monitoring program of the gillnet fishery, managed and compiled by the provincial government of N.B., for Escuminac and southeast N.B. from 1990 to 1996, and data from the DFO dockside monitoring of the 4T spring gillnet fishery from 1997 to 2013. Purchase slips were used for areas and years without dockside monitoring records. Effort was calculated as the number of trips multiplied by the number of nets, which is determined from the annual telephone survey of active herring fishers or dockside monitoring data where available. The data were aggregated by year, fishery area and day. Spring catch and effort dockside monitoring data are available for 1990-2013.

For the fall CPUE series, catch data were taken from purchase slips and ZIF files collected by Statistics Branch available since 1978. Effort was calculated as the number of trips (purchase slips) multiplied by the number of nets or hauls, which were determined from the annual telephone survey of active herring fishers or dockside monitoring data where available. The data were aggregated by year, fishery area and day. Data on the fall number of nets in the fall fishery are available since 1978 and the number of hauls since 1986.

For both spring and fall, annual trends in gillnet CPUE were calculated using a generalised linear model (GLM).

ACOUSTIC SURVEY

Since 1991, annual fishery-independent acoustic surveys of early fall (September-October) concentrations of herring in the southern Gulf have been conducted. The surveys are usually concentrated in the areas of Chaleurs-Miscou and north of P.E.I. These areas are where NAFO Division 4T herring aggregate in the fall. The survey design uses random parallel transects within strata.

In 2012, the acoustic survey covered two major areas of the 4T stock with a total transect distance covered of 1,289 kms (Fig. 7a). The areas surveyed were Chaleurs-Miscou from September 20 to 30 (Fig. 8a) and north P.E.I. from October 1 to 5 (Fig. 8b).

In 2013, the acoustic survey covered one area of the 4T stock with a total transect distance covered of 1,126 kms (Fig. 7b). The area surveyed was Chaleurs-Miscou from September 20 to 30 (Fig. 9). Due to bad weather, the coverage of the north P.E.I. area was not possible in 2013.

Two vessels were used in the survey: an acoustic vessel to quantify the biomass of fish schools, and a fishing vessel to sample aggregates of fish. The acoustic vessel used was the *CCGS F. G. Creed*, with a hull-mounted 120 KHz transducer, and using a Femto DE9320 digital echosounder. The fishing vessels were the *CCGS Calanus II* in 2012 and the *CCGS M. Perley* in 2013, using a Nordsea midwater trawl, with horizontal and vertical openings of 11 and 7 m respectively, a length of 36.2 m and minimum mesh size of 4 cm in the codend.

Sampling was carried out wherever major concentrations were detected acoustically to determine species composition, biological characteristics and size distribution for the estimation of the target strength (appendices 1 and 2). Methods used are detailed in LeBlanc and Dale (1996). The 2012 and 2013 survey results are presented in Appendices 3a to 3f.

The 2013 acoustic biomass index of the Chaleurs-Miscou area for the combined spring and fall spawner components has been similar in value since 2006, and is near the lowest value of the time series for all the Chaleurs-Miscou area strata and for the strata that have been surveyed every year since 1994 (Fig. 10). In recent years, there has been a slight increase in herring density and biomass in the Chaleurs-Miscou area (Fig. 11).

The acoustic numbers and biomass at age detected in the 2012 acoustic survey for Chaleurs-Miscou and north P.E.I. areas, as well as the 2013 acoustic survey for Chaleurs-Miscou, are summarised in Table 11.

In 2012, the biomass detected in the Chaleurs-Miscou area was estimated at 87,393 t, of which 22.6% (19,758 t) were spring spawners (by weight). In the north P.E.I. area, the estimated 2012 biomass was 14,136 t, of which 5% (702 t) were spring spawners (by weight). In 2013, the biomass detected in the Chaleurs-Miscou area was estimated at 75,529 t, of which 15.2% (11,446 t) were spring spawners (by weight).

The catch (length frequency) by set was weighted by the sum of acoustic herring densities recorded in the stratum or group of strata defined in the catch-at-age parameters as representing the biomass in that area. Using the herring densities recorded as the weighting factor is considered a better method as it does not depend on an estimated standardized amount of herring caught in a set of one nautical mile. With this method, sets made where herring densities were greater are given more weight, regardless of the set duration.

Catch-at-age by spawning group for the acoustic abundance index was calculated from Chaleurs-Miscou detailed samples collected from the same strata covered since 1994, paired with the acoustic biomass estimate for those strata. The data collected from north of P.E.I. have not been incorporated because of the shorter time series and inconsistency of coverage for this area over the years.

From this catch-at-age by spawning group, correlation of age-class abundance from one year to the next, as well as with a 2 and 3 year lag was examined. Good correlation was found for the spring spawning component, the best being for a one year lag in numbers-at-age. The fall spawning component showed poor correlation (Table 12).

GILLNETTER TELEPHONE SURVEY OPINION

During the annual gillnetter telephone survey started in 1986, one question asked the harvesters to compare the abundance of herring in the current year to the previous year. The responses were scaled from 1 to 10, with 5 meaning no change from the previous year. To construct the index, the responses were re-scaled from –5 to +5, with 0 indicating no change of abundance. The annual opinion responses were averaged by area and then weighted by the catch in that area. A global yearly weighted average was calculated and yearly averages were added cumulatively, to give a trend of abundance from 1987 to the current year. A positive slope indicates harvester opinions consistent with an increasing stock abundance, and a negative slope indicates decreasing abundance.

In 2008, a review of the use of the gillnetter telephone survey opinion on abundance as an aggregated biomass index in the model was done. Conclusions were that respondents in the gillnet telephone survey provide an honest opinion of their perception of recent changes in herring abundance, but that opinion is not related in a constant manner to changes in the same respondent's herring catch rates. It was concluded that this index should not be used as an aggregated biomass index in the population model formulation.

GROUNDFISH BOTTOM TRAWL SURVEY

The annual groundfish bottom trawl survey provides some information on the distribution of 4T herring throughout the sGSL in September. The survey has been conducted consistently during the month of September since 1971. Herring were found primarily near shore in shallow waters, mostly west, north and east of P.E.I., in Northumberland Strait and in St. Georges Bay (Fig. 12).

In the September 2012 and 2013 groundfish surveys, herring were caught primarily near shore in waters < 30 fathoms, mostly north and east of P.E.I., west of Cape Breton, as well as in the Northumberland Strait and St. Georges Bay (Fig. 12). The length frequency distributions consisted of a proportion from 19 to 26 cm which would mainly be age 2 and 3 herring (Fig. 13). The proportion at around 28 cm in 2012 would be age 4 and older herring. There were very few catches of herring larger than 30 cm.

REVIEW OF SIZE AT 50% MATURITY

The mean fork length at maturity (L50) for the southern Gulf of St. Lawrence Atlantic herring stocks for the years 1999-2006 was estimated at 23.5 cm. (DFO 2007; LeBlanc and Morin 2008). Advice was requested by DFO Fisheries and Aquaculture Management to determine the current size at 50% maturity for the sGSL herring stocks.

Biological data from the acoustic survey from 2007 to 2013 were used because they were considered to be less biased by gear selectivity compared to data from gillnet catches. Two maturity classes were created from the gonad maturity data of individual fish of both spawning components from the detailed samples: immature herring or juveniles and mature herring comprised of pre-spawning, spawning and post-spawning herring. For the purpose of this analysis, total length was converted to fork length using a conversion established from laboratory measurements.

By using the acoustic survey data, the main fall concentrations of herring were sampled during fall feeding and migration in the sGSL. By weighting the data to local abundance from the survey, emphasis is placed on the main distribution of herring at that time of year, ensuring that the average L50 estimate reflects any regional differences.

In the acoustic survey, herring tended to be concentrated in Chaleur Bay and 75% or more of the samples came from this area. However, there was sufficient sampling from P.E.I. to permit an analysis comparing Chaleur-Miscou with the area north of P.E.I.

Maturity data were modeled as a function of fork length using generalized linear models (GLMs) with a logit-link function. Year, sex and region categorical variables were tested for significance using likelihood-ratio tests. The size-at-maturity (L50) is defined as the fork-length at which the fitted maturity curve yields an equal (i.e. 0.5) probability of being either immature or mature.

As inferences are desired regarding the fishable population, the data were weighted by the acoustic biomass estimate for the area. Confidence intervals (95%) about the estimated L50 values were obtained by bootstrap resampling of the inference model (n = 1000) and extracting the 2.5th and 97.5th percentiles.

L50 was significantly greater in the Chaleur-Miscou area than north of P.E.I. Based on recent acoustic survey length at maturity data, the average mean fork length at 50% maturity (L50) over the 2007 to 2013 period is estimated at 21.6 cm for sGSL herring and shows a decreasing trend over time (Figure 14).

SPRING SPAWNER COMPONENT (SSC)

SPRING FISHERY

The 4T spring gillnet fishery captured 27% of their spring allocation in 2012 and 59% of their spring allocation in 2013.

The opinions on abundance from the telephone survey of active gillnet fishers indicate a similar or a slight increase in spring herring abundance for the four areas who responded (Fig. 15).

Most spring gillnets measure from 12 to 15 fathoms long and range from 44 to 100 meshes deep, with mesh sizes ranging from 2¼ to 2½ inches. In the spring, nets are fished by anchoring overnight (set nets) and picked up the next morning (Tables 7 and 9).

The percentage of days with no catch in the spring gillnet fishery was 43% in 2012 and 36% in 2013 (Table 8). This high percentage is part of the effort data that should be taken into account when determining the gillnet catch per unit effort. Unfortunately, this information was not collected and is not available prior to 2006.

The landings and samples by area used to calculate catch-at-age in the 2012 and 2013 spring fishery are described in Table 13. The SSC catch-at-age and weight-at-age were determined for each gear type and for all gears combined (Tables 14 to 16). Catches of the SSC in 2013 were composed mostly of ages 5, 6 and 7 (Table 16; Figs. 16 and 17).

Mean weights-at-age for the SSC were lower in recent years than during the 1990s (Table 16; Fig. 18). The mean weights observed in recent years are declining for most ages. Lower mean weights are an indication of the status of the stock, and affect the stock biomass estimate when numbers are converted to weight.

SPRING SPAWNER COMPONENT ABUNDANCE INDICATORS

Gillnet fishery CPUE index

Daily effort was estimated by multiplying the number of trips by the average number of standard nets per fisher for each area (Table 17). The fishing effort for the season was obtained by adding the fishing effort for all days. Thus, the units of measurement for effort were net-days. The mesh size of gillnets used in the spring fishery has not changed significantly over time with 2¼ to 2½ inch mesh the most common.

The 2012 and 2013 preliminary spring season gillnet landings by month and area are summarized in Table 18. In recent years, it was noticed that landings from the late spring gillnet fishery (mainly June) have increased significantly and make up a larger amount of the total spring gillnet landings. A closer examination of the composition of the spring season gillnet catches revealed that a proportion of the June catches were of the fall spawner component, while catches in April and May are mostly of the spring spawner component caught on the spawning grounds. In light of this catch composition in June, it was concluded that the spring gillnet fishery CPUE index should not include catch data from June in order to better reflect the spring spawner component abundance.

Since the 2002 assessment, it was concluded that the catch-weighted index appears to be more consistent with the SSC stock trends (Poirier 2002; LeBlanc et al. 2003). Therefore, the gillnet CPUE series chosen to calibrate the 2013 SPA model for the SSC assessment included the April and May dockside monitoring data (1990-2013) from all areas, aggregated by day and area and weighted by the catch for that area.

To estimate annual gillnet CPUE abundance indices, we used a multiplicative model (GLM) with week, area, and year (1990-2013) effects. The model formulation was:

$$\ln(CPUE_{ijk}) = \alpha + \beta_1 I + \beta_2 J + \beta_3 K + \epsilon$$

where:

$CPUE_{ijk}$ = CPUE in year *i*, area *j*, week *k*

I is a matrix of 0 to 1 indicating year

J is a matrix of 0 to 1 indicating area

K is a matrix of 0 to 1 indicating week

ϵ is the residual error.

The model explained a significant amount of the variation in ln(CPUE) ($r^2 = 0.44$; $p < 0.0001$) (Table 19). The residuals suggested no violations of assumption of the normal distribution and revealed no points that may have unduly influenced the parameter estimates.

The estimated catch rates in kg/net/trip have been declining since 1998, with the 2010 to 2012 catch rates being the lowest in the time series. The 2013 catch rate was higher than the three previous years (Fig. 19). An age-disaggregated abundance index for ages 4-10 and years 1990 to 2013 was calculated by dividing the gillnet catch-at-age b the standardized effort from the multiplicative model (Table 20).

Internal consistency of the CPUE index by age for the SSC was examined with regressions of age-class abundance with a one year lag. The internal consistency of the regressions show a good fit (Fig. 20).

Acoustic survey index

A second standardized abundance index was generated from the annual acoustic survey. This index includes catch-at age data from Chaleurs-Miscou strata surveyed yearly since 1994. During this time period, the survey was conducted with the vessel *CCGS F. G. Creed* and all transects were covered at night.

The 2012 Chaleurs–Miscou acoustic survey catches of the SSC were dominated by the 2009 year-class (ages 3 in 2012). The 2013 Chaleurs–Miscou acoustic survey catches of the SSC were dominated by the 2008 and 2009 year-classes (age 4 and 5 in 2013) (Table 21; Fig. 21).

Internal consistency of the acoustic index by age for the SSC was examined with correlations and regressions of age-class abundance with a one to three year lag (Table 12). For all year lags, the internal consistency is generally good, with five of the seven regressions showing a good fit (Fig. 22).

The acoustic survey estimated catch rates (in numbers) of spring spawners of age 4 to 8 increased slightly in 2012 and 2013, but remain at a low level in the time series (Fig. 23). The age-disaggregated abundance index includes ages 4-8 and years 1994 to 2013 (Tables 20 and 21).

Gillnetter telephone survey opinion on abundance

The global 4T cumulative spring index of gillnetter opinion on abundance reached a peak in 1998, then declined abruptly until 2008, but showing an increase since 2009 (Fig. 24).

Comparison of abundance indicators

The opinion of gillnet harvesters from the telephone survey indicates a sharp decline in the perceived status of the stock after 1998, while the gillnet CPUE and acoustic survey indices indicate a more gradual decline. In 2012, the indices were similar to 2011. In 2013, all three indices show a slight increase. Overall the indices remain at a low value in the time series (Fig. 25).

SPRING SPAWNER COMPONENT ASSESSMENT

The determination of resource status of 4T spring spawning herring was attempted using a population analysis model with the ADAPT software (Gavaris 1999).

Spring spawner component ADAPT calibration

The 2011 assessment model used both the age-disaggregated gillnet CPUE index and the acoustic survey index, both proportional to abundance (LeBlanc et al. 2012). For the acoustic survey index, it was decided to use the ages 4 to 8 only, as the inclusion of the age 3 index resulted in an age 4 population estimate that was imprecise.

For the 2011 population analysis model trials, several estimates were attempted using different combinations of indices. Model calibration trials with a power function attributed to the CPUE index were examined. The results showed that the power estimates were different than one but that the estimates of catchability were much less precise than the proportional model. This calibration was not deemed usable as the final model application.

The model using both the age disaggregated gillnet CPUE index and the acoustic survey index, both proportional to abundance, was chosen as the best representation of stock status in 2013 and was used for the assessment.

The 2013 assessment model input catch-at-age included ages 4 to 11+. The gillnet CPUE series included ages 4 to 10. The acoustic survey index included ages 4 to 8. The formulation for the calibration was as follows:

- Parameters
  - Terminal N estimates:
    - $N_{i,2014}$, i = ages 5 to 10
    - $N_{10,2013}$
    - $N_{10,2012}$
    - $N_{10,2011}$
- Calibration coefficients:
  - Gillnet CPUE ages 4 to 10
  - Acoustic survey ages 4 to 8
- Structure Imposed:
  - Error in catch-at-age assumed negligible
  - Natural mortality (M) = 0.2
  - Oldest age F: F10 using FIRST method (Gavaris 1999)
  - F10 = average (F8+F9)
  - F11 = F10
  - CPUE and acoustic indices proportional to abundance
- Input:
  - C_{ik}, i = ages 2 to 11, k = years 1978 to 2013
  - Gillnet CPUE, i = 4 to 10, k = 1990 to 2013
  - Acoustic survey, i = 4 to 8, k = 1994 to 2013
- Objective Function:
  - Minimise sum of squared log normal residuals
- Summary:
  - Number of observations: 268
  - Number of parameters: 22

The parameter variance was estimated analytically. Results indicated a model fit with a mean square residual of 0.68 (Table 22). The diagnostics for the model indicate that the relative error around the population estimates for ages 5 to 10 were between 0.33 and 0.61. There is a higher relative error on the age 5 estimate (0.61).

The residual plots for the age-disaggregated indices (Fig. 26) show some distinct patterns with year effects, with mostly negative values from 1989 to 2002 and mostly positive values from

2003 to 2009. Another representation of the fit of the model with the indices is the comparison of CPUE and acoustic indices corrected for catchability and the model estimates of population abundance (Fig. 27).

Both the gillnet CPUE and the acoustic survey indices indicate a decline in the SSC biomass since the 1990s. However, they do not show the same extent of decline. The CPUE index indicates a less steep decline than the acoustic survey. There are reasons to expect that changes in gillnet CPUE will underestimate the true changes in population abundance and biomass:

- At high levels of abundance, gillnets may become saturated.
- Zero catches are not included in the CPUE calculation.
- Because the fishery targets spawning aggregations, relatively high catch rates can be maintained even at low levels of herring biomass.

On the other hand, there is no a priori reason to expect a bias in the acoustic survey index.

Based on Figures 26 and 27, the model appears to be averaging between the two indices and indicating an intermediate decline. Both indices show a slight increase in 2013.

A retrospective analysis (Fig. 28) indicated a slight tendency to overestimate biomass since 2006. With the addition of the 2012-2013 data, the estimates are similar for the most recent years.

Spring spawner component - assessment results

The previous five years average survival ratio (number at age in a year-class / Spawning Stock Biomass producing that year-class) were used to estimate the average numbers of ages 2 to 4 in 2014 (Fig. 29). The results of this analysis suggest that population abundance of SSC herring in 4T had declined since 1995, but is now showing a slight increase since 2006 (Fig. 30). The analysis indicates that both population abundance and biomass of ages 4+ SSC peaked in 1995, when the large 1991 year-class entered the fishery as 4 year-olds.

The population number at age 4 for 2014 was set at the number produced by the 2009-2013 mean survival ratio for age 4 multiplied by the estimated spawning stock biomass (SSB) in 2010 (Table 23). The 2014 beginning-of-year ages 4-11+ SSB was estimated to be about 22,280 t (Table 24; Fig. 30).

Average age 6 to 8 fishing mortalities from the ADAPT CPUE and acoustic calibration model suggest higher fishing mortalities for most ages from 1999 to 2005 and in 2007 (Table 25). The model suggests that the abundance of year-classes after 1991 were average or below average.

The reference level exploitation rate at F0.1 for the SSC was about 27% for fully recruited ages 6 to 8. The estimated exploitation rate had been above the reference level from 1999 to 2008, and below since 2009 (Fig. 30).

Spring spawner component prospects

Stock projections were conducted and input parameters are presented in Table 26. It was noted that, for partially recruited fish, calculating beginning of year weights at age based on the commercial weights at age biases the results in favor of the faster growing fish. Thus acoustic survey samples were used to calculate weights at age that are more representative of the partially recruited age classes (ages 2 to 4). The fishery weights at age used in the projections were the average of 2011 to 2013. The 2014 beginning-of-year weights at age were averaged from the 2011 to 2013 commercial and acoustic survey weights adjusted to the beginning of the year. Partial recruitment was derived from fishing mortalities for 2011 to 2013.

The analysis suggested that fishing at F0.1 (corresponding to a fully-recruited F = 0.35) would yield 5,995 t in 2014 for ages 2 to 11+ (Table 27). Fishing at F0.1 is considered a safe exploitation rate only when the spawning stock biomass level is in the healthy zone.

For the spring spawning component, the limit reference point (LRP or Blim) and interim upper stock reference (USR) points are 22,000 and 54,000 t, respectively (DFO 2005). The current estimate of SSB (22,280 t) is at Blim (Fig. 31). The application of the precautionary approach requires that removals when the stock is in the critical zone should be kept to the lowest level possible.

The risk analyses conducted were:

- the probability of no decline in biomass,
- the probability of a 5% increase in biomass,
- the probability of a 5% decline in biomass, and
- the probability of SSB being lower than 22,000 t (Blim).

With a catch option of 1,000 t in 2014, there is a 95% probability that the biomass in 2015 will increase by 5%. Catch options less than 2,000 t would provide a low probability of further decline in biomass from the current level of 22,280 t (Fig. 32). The Armstrong plot shows the biomass changes and exploitation rates expected, given catches between 0 and 9,000 t (Fig. 33).

Spring spawner component two year projection

Risk analyses were conducted by projecting the population forward from the beginning of 2014 to the beginning of 2016, taking into account uncertainty in the population abundance at age in 2014 and recent variability in recruitment rates and beginning-of-year weights-at-age. These projections rely on the assumption that recent levels of productivity (recruitment rates, weights at age, and natural mortality rate) will persist over the projection period.

This was done using 1,000 bootstrap replicates of terminal population abundance at ages 5 to 11+ years produced when fitting the ADAPT model. Each of 1,000 projections was started by randomly selecting one of these bootstrap replicates. Abundances at ages 2 in 2014 - 2016 were obtained using the spawning stock biomass (SSB) producing these year-classes (i.e., the SSB two years earlier) and a recruitment rate to age 2 (recruits/SSB) randomly selected from those observed over the recent period with estimates of age-2 recruits (2007-2011). For spring spawners, abundances at ages 3 and 4 years in 2014 were also obtained by randomly sampling one of the most recent five estimates of recruitment rates to these ages.

Other inputs to the projections (natural mortality M, maturity at age, partial recruitment to the fishery at age, beginning-of-year weights-at-age and commercial weights-at-age) were the same as those used in the ADAPT projections (Table 26). Various levels of catch were used in the projections, with the same level used in both years. The probability of a given event was estimated as the proportion of the projection iterations in which that event occurred. For example, the probability of an increase in SSB from 2014 to 2016 was the proportion of projections in which SSB in 2016 was greater than SSB in 2014.

Results

Projections were done with levels of catch between 0 and 5,000 t in 500 t increments. The probability that SSB would be less than the limit reference point (Blim) of 22,000 t at the start of 2016 varied from 0.1% with no catch to 40% with a catch of 5,000 t in each year (Fig. 34a). Based on the conditions assumed in the projections, the probability that SSB will be above the upper stock reference point (USR) in 2016 is less than 0.5% at all levels of catch, including no catch. The probability of an increase in biomass from 2014 to 2016 ranged from 99.8% with no catch to 18% with catches of 5,000 t each year (Fig. 34b).

FALL SPAWNER COMPONENT (FSC)

FALL FISHERY

The 4T fall gillnet fishery captured 95% of their fall allocation in 2012 and 89% of their fall allocation in 2013.

The opinions on abundance from the fall gillnet fishery telephone survey were that abundance was lower in the Acadian Peninsula and East P.E.I. areas, while equal or higher in Quebec, Escuminac, southeast NB, West P.E.I., and Nova Scotia (Fig. 35).

Gillnetter's comments on the 2013 fall fishery varied by area. Gillnetters in some areas were concerned about a marked decrease in abundance, while other areas are seeing an increase in abundance. Certain areas commented that the season opening was too late, reported an increase in daytime fishing and noted that a perceived high abundance of tunas had scared the herring.

Other information from the gillnetter telephone survey indicated that 2⅝ inch was the most commonly used fall mesh size. In 2012 and 2013, most nets were 14 to 15.6 fathoms long and ranged from 80 to 118 meshes deep (Tables 7 and 9). In the fall, gillnetters search for spawning grounds and nets are set only when a school of sufficient size is found. In Quebec and the Acadian Peninsula, most gillnets were fished with one end tied to the vessel and the other anchored (modified nets). In other areas, most of the gillnets are anchored at both ends and two or more strings may be set (set nets) (Table 7).

The percentage of days with no catch in the fall gillnet fishery was 24.2% in 2012 and 22.8% in 2013 (Table 8). This high percentage is part of the effort data that should be taken into account when determining the gillnet catch per effort. Unfortunately, this information was not collected and is not available prior to 2006.

In the 2012 fall fishery, 75% of the total fall TAC was attained; seiners caught 7% of their allocation while the inshore gillnet fleet caught 95% of their allocation. In the 2013 fall fishery, 74% of the total fall TAC was attained; seiners caught 21% of their allocation while the inshore gillnet fleet caught 89% of their allocation.

The landings and samples by area used to calculate catch-at-age in the fall fishery are described in Table 28a for 2012 and 28b for 2013.

The FSC catch-at-age and weights-at-age by gear type and for all gears combined are summarized in Tables 29 to 31 and Figures 36 to 38. Inshore gillnet fleet catches of the FSC in 2013 were dominated by the 2004 year-class (age 7 in 2013) and the 2005 year-class (age 6 in 2013).

In general, mean weights-at-age for the FSC had declined during the 1990s from the level of the 1980s, and continue to decline in recent years (Table 31; Fig. 38). Changes in mean weight are an indication of the status of the stock, and affect the stock biomass estimate when numbers are converted to weight.

FALL SPAWNER COMPONENT ABUNDANCE INDICATORS

Gillnetter telephone survey opinion on abundance

The global 4T fall index of gillnetter opinion on abundance had been on an increasing trend up to 2006, but has been declining since 2007 (Fig. 39).

Acoustic survey index

A FSC abundance index from the acoustic survey was derived using catch-at-age data from those strata consistently surveyed in the Chaleurs-Miscou area from 1994 to 2013. The 2012 acoustic survey catches of the FSC were dominated by the 2009 year-class (age 3). The 2013 acoustic survey catches of the FSC were dominated by the 2009 year-class (age 4) followed by the 2007 year-class (age 6) (Table 32; Fig. 40).

The Chaleurs–Miscou acoustic survey FSC catch proportion of adult herring (4+) were compared to the seiner catches for the same area and time period to verify if the midwater trawl provides unbiased samples of the area and time period surveyed. In general, the acoustic survey FSC catch proportions are similar to the seiner catches (LeBlanc et al. 2007). The same comparison between the acoustic survey FSC catch proportions of adult herring (4+) and the gillnet catch proportions indicates less similarity, especially in catches of older herring.

Internal consistency of the acoustic index by age for the FSC was examined with correlations and regressions of age-class abundance with a one to three year lag (Table 12). The fall spawner catch-at-age from the acoustic survey still shows little correlation with cohorts from one year to the next, except for moderate relationships for ages 2 to 3 and ages 9 to 10 (Fig. 41). In 2012 and 2013, the number of 4+ adult fall spawners and ages 4 to 8 numbers increased from levels observed in 2011 (Fig. 42).

A fall spawner index of abundance for ages 3 to 8 from the acoustic survey was tried in the population model but this increased the mean square error. Due to the poor internal consistency, it was not used as an age-disaggregated abundance index.

An alternate fall spawner index of abundance for ages 2 and 3 from the acoustic survey was included in one population model and used as an age-disaggregated juvenile abundance index (Fig. 43). This age-disaggregated juvenile abundance index includes years 1994 to 2013 (Table 7).

Gillnet fishery CPUE index

A FSC abundance index was derived from the catch per unit effort (CPUE) from the fall gillnet fishery. Since 2005, the number of standard nets was also obtained from dockside monitoring data in areas where the number of records was greater than the number of telephone survey respondents (Table 33). In 2001, the index was modified to incorporate all fishing areas (Poirier 2002).

In the fall gillnet fishery, 2⅝ inch mesh was most common. Beginning in 1992, many fishers started using bigger mesh sizes but by 2002, the proportion of 2⅝ inch mesh reverted to pre-1992 numbers. The proportion since 2008 has been between 94% and 99% (Table 34).

The current gillnet CPUE index, which was accepted in the 2008 assessment as the best fit, is called CPUE. CPUE is defined as catches in kg per net*hauls per day (or kg/net*hauls/trip). The daily fishing effort was calculated by multiplying the number of standard nets by the number of hauls (Table 35; Fig. 44), and the number of trips taken that day. Thus, the units of measurement for effort are net*hauls-days or net*hauls-trips. The number of hauls per day has been derived from the telephone survey which began in 1986. The telephone survey question was: “How many times each day did you empty your nets in the fall?”

The fall spawner gillnet CPUE index at age shows that abundance of cohorts is usually well correlated from one year to the next (Fig. 45).

Since the 2002 assessment, it was concluded that the gillnet CPUE index, non-weighted by the catch, appears to be more consistent with the FSC stock trends (Poirier 2002; LeBlanc et al. 2003). Therefore, the CPUE series chosen to calibrate the 2013 SPA models for FSC was the CPUE series not weighted by the catch and unadjusted for mesh size changes.

A multiplicative model (GLM) using weekly periods, area (all statistical districts) and year (1986-2013) effects was used to estimate the annual gillnet CPUE abundance index. The model formulation was:

$$\ln(CPUE_{ijk}) = \alpha + \beta_1 I + \beta_2 J + \beta_3 K + \epsilon$$

where:

$CPUE_{ijk}$ = CPUE in year *i*, area *j*, week *k*

I is a matrix of 0 to 1 indicating year

J is a matrix of 0 to 1 indicating area

K is a matrix of 0 to 1 indicating week

ϵ is the residual error.

The multiplicative model for CPUE, in which data were aggregated by statistical district and day, was statistically significant ($p<0.0001$; $r^2 = 0.45$) (Table 36). Residual plots revealed no trends or violations of assumptions of normal distribution but some year effects. The results indicate that the gillnet CPUE index in 2013 was higher than the two previous years and similar to 2010 (Fig. 43).

The age-specific abundance index for ages 4 to 10 was derived by dividing the fall gillnet catch-at-age by the standardised effort from the model (Table 37). The CPUE age-specific abundance index included the years 1986 to 2013.

A comparison of the acoustic and gillnet catch rates (CPUE) for fall spawner ages 4 to 9 was conducted (Fig. 46). There was little correspondence between the CPUE abundance index and the acoustic abundance index, which mostly follow different trends.

FALL SPAWNER COMPONENT ASSESSMENT

Simulations and models presented

In the 2011 assessment (LeBlanc et al. 2012), the sequential population analysis (SPA) model was calibrated with the gillnet fishery CPUE index (ages 4-10) and the acoustic survey juvenile index (ages 2-3), both considered proportional to population abundance in the model. For this assessment, trial formulations of the population analysis model were attempted using different combinations of indices.

From these trial formulations, two assessment models that varied in the assumptions about catchabilities in the fixed gear for ages 4 and 5 were evaluated. Neither model was considered superior for assessing stock status and providing catch advice, therefore the results from both models are presented.

MODEL 1 was the same model formulation accepted in 2011 where the CPUE index (ages 4-10) and the acoustic survey juvenile index (ages 2-3) were both considered proportional to population abundance. After examination of the MODEL 1 outputs, it was noted that the gillnet CPUE index for ages 4 and 5 might not be proportional to population abundance in the most recent years. Since the size-at-age has diminished (Fig. 38), the proportion of ages 4 and 5 caught by the gillnets has diminished (Tables 37 and 38). It was considered that for these TWO ages, there might be a trend in catchability in the most recent time period.

MODEL 2 SPLIT CPUE was calibrated with a split gillnet fishery CPUE index; ages 6 to 10 (1986-2013) as CPUE1 index, ages 4 and 5 (1986-2003) as CPUE2 index, both considered proportional to population abundance, while ages 4 and 5 (2004-2013) as CPUE3 index with a trend in catchability rather than proportional. Also included was the acoustic survey juvenile index (ages 2-3), considered proportional to population abundance in the model.

These two FSC population model calibrations and results are presented in this paper.

MODEL 1 with CPUE and acoustic indices proportional

Adapt calibration MODEL 1

The 2013 assessment MODEL 1 calibration is summarized. The CPUE (nets*hauls) and acoustic juvenile indices are considered proportional to abundance in the model. The input catch-at-age included ages 4 to 11+. The calibration of the FSC SPA used the gillnet CPUE abundance index ages 4 to 10, not weighted by the catch, and the acoustic juvenile index ages 2 and 3. The software used to conduct the SPA was ADAPT (Gavaris 1999). This formulation was as follows:

- Parameters
    - Terminal N estimates:
        - $N_{i,2014}$, i = ages 3 to 10
- Calibration coefficients:
    - Gillnet CPUE ages 4 to 10
    - Acoustic juvenile index ages 2 and 3
- Structure Imposed:
    - Error in catch-at-age assumed negligible
    - Natural mortality (M) = 0.2
    - Oldest age F: F11 using FIRST method (Gavaris 1999)
    - F10 = average (F8+F9)
    - F11 = F10
    - CPUE and acoustic juvenile indices proportional to abundance
- Input:
    - C_{ik}, i = ages 2 to 11, k = years 1978 to 2013
    - Gillnet CPUE index $_{ik}$, i = 4 to 10, k = 1986 to 2013
    - Acoustic juvenile index $_{ik}$, i = 2 to 3, k = 1994 to 2013
- Objective Function:
    - Minimise sum of squared log normal residuals
- Summary:
    - Number of observations
        - CPUE and acoustic = 238
    - Number of parameters = 19

The MODEL 1 parameter variance was estimated analytically. The diagnostics for the model using CPUE and juvenile acoustic indices (Table 39) indicate that the coefficient of variation (relative error) for age 3 was higher (0.69) than for other ages (0.39 – 0.50). Examination of the correlation matrix did not indicate any high values that would render the parameter estimates suspect. The residual plots for the CPUE index (Fig. 47) show year trends, with mostly positive residuals from 1997 to 2000 and negative residuals in the 1980s. Another representation of the fit of the MODEL 1 with the index is the comparison of CPUE and juvenile acoustic indices corrected for catchability and the MODEL 1 estimates of population abundance (Fig. 48).

Retrospective patterns were present in MODEL 1 with the addition of the 2013 data, suggesting some overestimation of abundance before 2010 and underestimates in 2010 to 2013 (Fig. 49). No adjustments of population estimates were done for the beginning of 2014.

MODEL 1 Fall spawner component assessment results

The average survival ratio (number at age in a year-class / Spawning Stock Biomass (SSB) producing that year-class) for the previous five years was used to estimate the numbers at age 2 in 2014 (Fig. 50).

The population number at age 2 for 2014 was set at the number produced by the 2009-2013 mean recruitment ratio for age 2 multiplied by the estimated SSB in 2012. Recruitment estimates (age 4) from the CPUE and juvenile acoustic indices MODEL 1 analysis suggest that the abundance of the 2004 and 2005 year-classes were above average, but the 2008 year-class (age 4 in 2012) was the lowest since 1995 (Table 40; Fig. 51). Very low abundance is projected for the 2010 year-class.

The MODEL 1 SPA formulation indicates that population biomass of ages 4+ FSC peaked in 2009, when the large 2004 and 2005 year-classes contributed to the fishery, but declined sharply from 2010 to 2014. The 2014 beginning-of-year age 4+ biomass was estimated to be about 98,993 t (Table 41; Fig. 51).

Overall, the average age 5 to 10 fishing mortalities for MODEL 1 were generally higher from 1994 to 2003 than in the most recent years, except 2013 which was higher (Table 42).

The MODEL 1 reference level exploitation rate for FSC was about 25% for fully-recruited age-groups (5+). The 2013 exploitation rate is above the target level (Fig. 51).

MODEL 1 Fall spawner component prospects

Stock projections were conducted for the ADAPT MODEL 1 formulated with the gillnet CPUE and juvenile acoustic indices for calibration. Estimated recruitment at age 4 was above average from 1999 to 2005, and again in 2008 and 2009, but below average in 2012 and 2013.

Input parameters for the MODEL 1 CPUE and juvenile acoustic indices projections are presented in Table 43. The acoustic survey samples were used to calculate weights at age for the partially recruited age-classes (ages 2 to 4). Older ages weights at age used were the average of 2011 to 2013 fishery weights at age. The 2012 beginning-of-year weights-at-age were averaged from the 2011 to 2013 commercial and acoustic weights. Partial recruitment derived from fishing mortalities from this assessment suggest that younger ages are less available to the fishery than previously. Thus, the partial recruitment vector used in projections was based on the fishery in recent years (2011-2013).

In a framework meeting conducted in December 2005, spawning stock biomass reference points were identified (DFO 2005). For the fall spawning component, the limit reference point (LRP or Blim) and interim upper stock reference (BUSR) are 51,000 and 172,000 t, respectively. The removal rate reference has been set at F0.1, which corresponds to F = 0.32 or about 25% of the fully-recruited age-groups (5+). Fishing at F0.1 is usually considered a safe exploitation rate when the stock is healthy. The current estimate of SSB using the CPUE and juvenile acoustic indices projection (98,993 t) is below the upper stock reference point of 172,000 t (Fig. 52).

The MODEL 1 projection using CPUE and juvenile acoustic indices indicates that fishing at F0.1 (corresponding to a fully recruited F=0.32) would yield 22,133 t in 2014 (Table 44).

A risk analysis can provide some guidelines for decision making. For the current estimates of SSB using the MODEL 1 CPUE and juvenile acoustic indices projections, the risk analysis considered the probability of exceeding F0.1, and those of obtaining a slight decline in biomass. For the MODEL 1 projections, a catch option of 22,133 t in 2014 corresponds to a 50% chance that exploitation rate would be above the reference removal rate. There is a 100% probability of a decline in biomass from 2013 for any catch level (Fig. 53). The Armstrong plot shows the biomass changes and exploitation rates expected given catches between 1,000 and 25,000 t (Fig. 54).

MODEL 2 SPLIT CPUE indices and acoustic index

ADAPT calibration MODEL 2

The 2013 assessment MODEL 2 calibration is summarized. The CPUE (nets*hauls) and acoustic juvenile indices are used in the model. The input catch-at-age included ages 4 to 11+. MODEL 2 SPLIT CPUE was calibrated with a split gillnet fishery CPUE index; ages 6 to 10 (1986-2013) as CPUE1 index, ages 4 and 5 (1986-2003) as CPUE2 index, both considered proportional to population abundance, while ages 4 and 5 (2004-2013) as CPUE3 index with a trend in catchability rather than proportional. Also included was the acoustic survey juvenile index (ages 2-3), considered proportional to population abundance in the model. The software used to conduct the SPA was ADAPT (Gavaris 1999). This formulation was as follows:

- Parameters
  - Terminal N estimates:
    - $N_{i,2014}$, i = ages 3 to 10
- Calibration coefficients:
  - Gillnet CPUE1 ages 6 to 10 (1986-2013)
  - Gillnet CPUE2 ages 4 to 5 (1986-2003)
  - Gillnet CPUE3 ages 4 to 5 (2004-2013)
  - Acoustic juvenile ages 2 and 3 (1994-2013)
- Structure Imposed:
  - Error in catch-at-age assumed negligible
  - Natural mortality (M) = 0.2
  - Oldest age F: F11 using FIRST method (Gavaris 1999)
  - F10 = average (F8+F9)
  - F11 = F10
  - CPUE1, CPUE2, and acoustic juvenile indices proportional to abundance
  - CPUE3 trend in catchability
- Input:
  - C_{ik}, i = ages 2 to 11, k = years 1978 to 2013
  - Gillnet CPUE index $_{ik}$, i = 4 to 10, k = 1986 to 2013
  - Acoustic juvenile index $_{ik}$, i = 2 to 3, k = 1994 to 2013
- Objective Function:
  - Minimise sum of squared log normal residuals
- Summary:
  - Number of observations
    - CPUE and acoustic = 238
  - Number of parameters = 19

The MODEL 2 parameter variance was estimated analytically. The diagnostics for the model using split CPUE and juvenile acoustic indices (Table 45) indicate that the coefficient of variation (relative error) for age 3 was higher (0.64) than for other ages (0.34 – 0.46). Examination of the correlation matrix did not indicate any high values that would render the parameter estimates suspect. The residual plots for the CPUE indices (Fig. 55) show year trends, with mostly positive residuals from 1997 to 2000 and negative residuals in the 1980s. Another representation of the fit of the MODEL 2 with the index is the comparison of CPUE and juvenile acoustic indices corrected for catchability and the MODEL 2 estimates of population abundance (Fig. 56).

Retrospective patterns were present in MODEL 2 with the addition of the 2013 data, suggesting some overestimation of abundance (Fig. 57). No adjustments of population estimates were done for the beginning of 2014.

MODEL 2 Fall spawner component assessment results

The average survival ratio (number at age in a year-class / Spawning Stock Biomass (SSB) producing that year-class) for the previous five years was used to estimate the numbers of age 2 herring in 2014 (Fig. 58).

The population number at age 2 for 2014 was set at the number produced by the 2009-2013 mean recruitment ratio for age 2 multiplied by the estimated SSB in 2012. Recruitment estimates (age 4) from the split CPUE and juvenile acoustic indices MODEL 2 analysis suggest that the abundance of the 2004, 2005, and 2009 year-classes were above average but the 2003 and 2008 year-classes were below average, with the 2008 year-class (age 4 in 2012) being the lowest since 1995. Very low abundance is projected for the 2010 year-class (Table 46; Fig. 59).

The MODEL 2 SPA formulation indicates that population biomass of ages 4+ FSC peaked in 2009, when the large 2004 and 2005 year-classes contributed to the fishery. With the split CPUE and juvenile acoustic indices formulation, the 2014 beginning-of-year age 4+ biomass was estimated to be about 182,812 t (Table 47; Fig. 59).

Overall, the average age 5 to 10 fishing mortalities for MODEL 2 were generally higher from 1994 to 2003 than in the most recent years (Table 48).

The MODEL 2 reference level exploitation rate for FSC was about 25% for fully-recruited age-groups (5+). The 2013 exploitation rate remains just below the target level (Fig. 59).

MODEL 2 Fall spawner component prospects

Stock projections were conducted for the ADAPT MODEL 2 formulated with the split gillnet CPUE and juvenile acoustic indices for calibration. Estimated recruitment at age 4 was above average from 1999 to 2005, and again in 2008 to 2011 and 2013, but below average in 2012 and 2014.

Input parameters for the MODEL 2 split CPUE and juvenile acoustic indices projections are presented in Table 49. The acoustic survey samples were used to calculate weights at age for the partially recruited age-classes (ages 2 to 4). Older ages weights at age were the average of the 2011 to 2013 fishery weights at age. The 2014 beginning-of-year weights at age were averaged from the 2011 to 2013 commercial and acoustic weights. The partial recruitment vector used in projections was based on the fishery in recent years (2011-2013).

The MODEL 2 projection using split CPUE and juvenile acoustic indices indicates that fishing at F0.1 (corresponding to a fully recruited F=0.32) would yield 38,017 t in 2014 (Table 50).

The current estimate of SSB using the split CPUE and juvenile acoustic indices projections (182,812 t) is above the upper stock reference point of 172,000 t (Fig. 60).

A risk analysis can provide some guidelines for decision making. For the current estimates of SSB using the MODEL 2 split CPUE and juvenile acoustic indices projections, the risk analysis considered the probability of exceeding F0.1, and those of obtaining a slight decline in biomass and the probability that the SSB will be below the URP of 172,000 t. For the MODEL 2 split

CPUE and juvenile acoustic indices projection, a catch option of 38,011 t in 2014 corresponds to a 50% chance that exploitation rate would be above the reference removal rate. There is a 100% probability of a decline in biomass from 2013 for all catch options (Fig. 61). The Armstrong plot shows the biomass changes and exploitation rates expected given catches between 10,000 and 50,000 t (Fig. 62).

Fall spawner component conclusion

Two models are presented because the diagnostics of the model fits do not allow a clear choice between models. The estimated absolute biomass values differ substantially between models however the trend in abundance from both is the same; biomass has declined from the recent peak value in 2009 and both models indicate that for catch options at F0.1, the biomass is expected to decline in 2015 and could decline into the cautious zone with model 2 whereas the biomass is in the cautious zone and will remain in the cautious zone or decline further with model 1.

Advice cannot be provided for more than one year (2014) for the fall spawner component because of important and unresolved model uncertainties. A review of the assessment approach is recommended including data inputs, alternate model formulations that could incorporate changes in natural mortality, changes in catchability and proportionality of indices.

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TABLES

Table 1. TAC allocation and preliminary herring catches (t) by season in the 2012 and 2013 fishery for 4T (southern Gulf of St. Lawrence). Catches are from ZIF and purchase slip files, from quota monitoring, and logbook data.

2012 – 2013 Fishing Season and Area	TAC (t)	*TAC sharing*		*Inshore*			*Seiners (> 65')*		
		Inshore	Seiners	Allocation	2012 Catch	2013 Catch	Allocation	2012 Catch	2013 Catch
Spring 4T	2,000	77%	23%	1,537	416	899	463	228	3,204
Fall 4T	43,500	77%	23%	33,522	31,886	29,929	9,978	643	2,057
Total (Spring + Fall)	45,500	77%	23%	35,059	32,302	30,828	10,441	871	5,261

Spring Fishery Area	Spring Fishery Season	TAC (t)	Spring 2012 Preliminary Catch (t)	Spring 2013 Preliminary Catch (t)
INSHORE				
16A - Isle Verte	Jan – May	4	15	6
16B - Baie des Chaleurs	Jan – May	71	307	377
16C – Escuminac	Jan – May	130	6	19
16D – Magdalen Islands	Jan – May	22	3	3
16E - Southeast N.B. and West P.E.I.	Jan – May	454	47	450
16F - Northumberland Strait and South Cape Breton	Jan – May	7	19	20
16G - East PEI and North Cape Breton	Jan – May	9	21	23
4Vn	Jan – June	16	-	-
16A – 16G (June)	June	62	-	-
Reserve	Jan – June	762	-	-
Total Inshore		1,537	416	899
SEINERS (>65 feet) in 4T	Jan 1 – Jun 30	463	228	3,204
Grand Total		2,000	644	4,103

Fall Fishery Area	Fall Fishery Season	TAC (t)	Fall 2012 Preliminary Catch (t)	Fall 2013 Preliminary Catch (t)
INSHORE				
16A - Isle Verte	July 1 – Dec. 31	88	10	20
16B – Chaleur Bay	July 1 – Dec. 31	15,093	14,937	15,440
16C – Escuminac and 16E - West P.E.I.	July 1 – Dec. 31	6,275	6,833	5,935
16D - Magdalen Islands	July 1 – Dec. 31	209	0	36
16F – Pictou	July 1 – Dec. 31	6,145	6,833	5,577
16G - Fisherman's Bank	July 1 – Dec. 31	5,476	3,273	2,922
Reserve	July 1 – Dec. 31	18	-	-
4Vn	July 1 – Dec. 31	218	-	-
Total Inshore		33,522	31,886	29,929
SEINERS (>65 feet)				
Chaleur Bay / Miscou	Sept. 1 – Dec. 31 Inside	4,989	643	2,057
Remainder of 4T	Outside	4,989	0	0
Total Seiners		9,978	643	2,057
Grand Total		43,500	32,529	31,986

Table 2. Fixed gear herring catches (t) by season (spring, upper table; fall, lower table) and fishing area in 4T southern Gulf of St. Lawrence, based on ZIF raw data files, purchase slip files, dockside monitoring or logbook data. Data for 2012-2013 are preliminary (*).

Year	16A	16B	16C	16D	16E	16F	16G	Total
Spring season								
1993	106	2,397	4,543	885	6,829	200	126	15,086
1194	311	1,561	6,284	218	10,842	158	76	19,450
1995	66	1,844	4,909	1,043	7,988	96	27	15,973
1996	101	882	5,423	1,628	9,016	231	579	17,860
1997	91	622	3,085	1,552	9,921	49	499	15,819
1998	60	441	3,024	1,907	8,104	176	611	14,322
1999	62	277	2,343	2,699	5,534	162	628	11,704
2000	62	911	2,336	3,855	8,372	127	526	16,189
2001	34	582	1,287	2,624	5,242	270	556	10,595
2002	12	595	1,106	2,155	4,053	499	590	9,010
2003	11	511	374	2,806	4,426	410	524	9,062
2004	20	694	325	3,087	3,696	564	516	8,902
2005	1	815	109	1,095	2,009	546	374	4,949
2006	7	835	73	160	611	597	377	2,660
2007	6	615	159	21	888	146	377	2,212
2008	13	499	58	71	859	76	114	1,689
2009	9	286	12	47	949	25	23	1,351
2010	15	533	41	90	193	97	187	1,156
2011	7	424	59	10	379	76	89	1,044
2012*	15	307	6	3	47	19	21	416
2013*	6	377	19	3	450	20	23	899
Mean of 2008-2012	12	410	35	44	485	58	87	1,131
Fall season								
1993	103	14,504	3,060	618	2,137	935	1,776	23,133
1194	118	34,414	4,367	1459	2,119	0	3,590	54,100
1995	60	29,992	4,921	1901	5,006	10,141	4,244	56,265
1996	86	21,741	2,841	1447	5,179	7,852	7,978	47,124
1997	106	18,460	2,013	407	4,447	6,278	7,331	39,041
1998	13	17,831	1,819	1213	6,197	5,498	7,045	39,615
1999	6	21,627	3,897	389	4,531	5,957	8,909	45,316
2000	16	24,474	5,403	291	4,890	5,048	10,366	50,488
2001	3	21,750	4,750	0	3,232	6,749	9,022	45,506
2002	23	18,666	4,655	0	3,257	8,007	7,448	42,056
2003	3	21,387	5,756	0	2,423	9,116	9,025	47,710
2004	2	14,764	7,056	8	2,910	5,477	6,990	37,207
2005	2	24,116	5,052	0	4,479	8,916	9,251	51,816
2006	5	21,645	4,637	14	4,125	8,960	8,532	47,918
2007	15	19,560	3,099	34	4,283	8,684	7,493	43,168
2008	11	18,766	2,820	71	5,126	5,332	6,739	38,865
2009	14	19,407	4,197	117	4,333	8,317	8,467	44,852
2010	10	15,803	3,754	177	5,792	7,951	8,970	42,457
2011	57	15,159	2,866	38	5,857	8,675	4,247	36,899
2012*	10	14,937	2,490	0	4,343	6,833	3,273	31,886
2013*	20	15,440	1,905	36	4,030	5,577	2,922	29,929
Mean of 2008-2012	20	16,814	3,225	81	5,090	7,422	6,339	38,992

Table 3. Catches (t) of 4T herring in spring and fall, by gear (fixed and mobile) divided by spawning group (calculated by the GSI method).

Year	SPAWNING GROUP P = spring A = fall	4T SPRING Fixed	4T SPRING Mobile	4T FALL Fixed	4T FALL Mobile	4T CATCH	4Vn CATCH	4TVn CATCH	4TVn TAC
1981	P	6,287	20	293	589	7,190	822		
	A	1,212	1	10,932	2,599	14,744	2,594		
	Total	7,500	21	11,225	3,189	21,934	3,416	25,350	19,000
1982	P	5,692	57	292	574	6,615	834		
	A	230	5	12,691	2,003	14,930	2,674		
	Total	5,922	62	12,983	2,578	21,545	3,508	25,054	18,000
1983	P	7,655	17	423	1,466	9,561	1,307		
	A	865	2	13,415	2,023	16,305	2,672		
	Total	8,520	19	13,838	3,489	25,866	3,979	29,845	25,000
1984	P	4,434	3	303	895	5,635	1,376		
	A	847	1	15,672	1,384	17,903	2,549		
	Total	5,281	4	15,975	2,278	23,538	3,925	27,463	22,500
1985	P	6,720	0	1,287	2,154	10,161	1,082		
	A	498	0	22,420	4,867	27,785	2,388		
	Total	7,218	0	23,707	7,021	37,946	3,470	41,416	36,000
1986	P	7,154	0	3,181	6,773	17,108	2,782		
	A	1,397	0	36,710	4,143	42,250	1,568		
	Total	8,551	0	39,891	10,916	59,357	4,350	63,707	47,600
1987	P	10,419	0	2,538	9,460	22,417	1,446		
	A	1,340	0	49,585	4,273	55,198	917		
	Total	11,759	0	52,123	13,733	77,615	2,363	79,978	77,000
1988	P	9,166	0	2,843	12,036	24,046	1,766		
	A	3,719	0	38,367	5,496	47,583	806		
	Total	12,886	0	41,210	17,533	71,629	2,572	74,201	83,100
1989	P	9,062	0	1,691	8,778	19,531	1,302		
	A	2,032	0	32,157	5,492	39,681	815		
	Total	11,093	0	33,848	14,270	59,211	2,117	61,328	91,100
1990	P	4,083	1	2,146	6,756	12,986	3,088		
	A	818	0	59,138	3,551	63,508	1,623		
	Total	4,901	1	61,284	10,308	76,494	4,710	81,204	91,100
1991	P	12,073	5	178	3,319	15,575	1,902	17,476	21000
	A	817	13	26,965	4,741	32,537	2,888	35,425	70,100
	Total	12,890	18	27,143	8,060	48,111	4,790	52,901	91,100
1992	P	12,291	641	322	3,327	16,581	493	17,074	21,000
	A	186	478	32,760	3,789	37,214	3,735	40,949	70,100
	Total	12,477	1,119	33,082	7,116	53,794	4,228	58,023	91,100
1993	P	14,643	1,526	780	3,741	20,690	434	21,123	21,000
	A	538	1,190	22,319	2,487	26,535	3,517	30,052	85,000
	Total	15,182	2,716	23,099	6,228	47,224	3,951	51,175	106,000
1994	P	18,498	883	481	3,357	23,220	568	23,787	21,000
	A	517	3,049	53,333	3,603	60,503	2,681	63,184	85,000
	Total	19,016	3,932	53,813	6,961	83,722	3,249	86,971	106,000
1995	P	15,137	950	2,102	7,671	25,860	470	26,330	21,000
	A	836	875	54,161	7,595	63,467	3,674	67,141	85,000
	Total	15,972	1,825	56,264	15,266	89,327	4,144	93,471	106,000
1996	P	15,409	441	1,365	3,977	21,193	1,033	22,226	15,114
	A	668	1,466	44,408	4,044	50,585	3,234	53,819	58,749
	Total	16,077	1,907	45,773	8,021	71,778	4,268	76,045	73,863
1997	P	12,846	614	98	3,627	17,184	231	17,416	16,500
	A	380	888	34,974	2,175	38,418	3,299	41,717	50,000
	Total	13,226	1,502	35,071	5,803	55,602	3,531	59,133	66,500
1998	P	13,382	297	121	1,418	15,218	2	15,220	16,500
	A	528	707	39,009	3,158	43,402	50	43,451	57,568
	Total	13,910	1,004	39,130	4,576	58,619	52	58,671	74,068
1999	P	10,256	688	176	3,770	14,889	0	14,889	18,500
	A	1,625	4,130	44,615	5,334	55,704	0	55,704	60,500
	Total	11,881	4,818	44,791	9,104	70,594	0	70,594	79,000
2000	P	14,586	10	706	2,324	17,626	0	17,626	16,500
	A	1,596	538	49,676	6,373	58,183	0	58,183	71,000
	Total	16,181	549	50,383	8,697	75,809	0	75,809	83,300
2001	P	9,938	459	736	2,986	14,120	0	14,120	12,500

Year	SPAWNING GROUP P = spring A = fall	4T SPRING Fixed	4T SPRING Mobile	4T FALL Fixed	4T FALL Mobile	4T CATCH	4Vn CATCH	4TVn CATCH	4TVn TAC
	A	659	638	44,786	7,285	53,368	0	53,368	60,500
	Total	10,597	1097	45,522	10,271	67,488	0	67,488	73,000
2002	P	8,142	420	673	704	9,939	0	9,939	8,000
	A	966	464	41,290	10,898	53,618	0	53,618	51,500
	Total	9,109	884	41,962	11,602	63,556	0	63,556	59,500
2003	P	8,458	41	37	449	8,986	0	8,986	11,000
	A	608	60	47,766	12,779	61,213	0	61,213	62,000
	Total	9,066	101	47,803	13,228	70,199	0	70,199	73,000
2004	P	7,671	21	122	410	8,223	0	8,223	13,500
	A	374	31	35,904	7,090	43,398	0	43,398	73,000
	Total	8,044	52	36,025	7,500	51,621	0	51,621	86,500
2005	P	3,571	0	14	1,084	4,669	0	4,669	11,000
	A	925	0	51,715	7,756	60,396	0	60,396	70,000
	Total	4,496	0	51,729	8,840	65,065	0	65,065	81,000
2006	P	1,409	0	293	745	2,447	0	2,447	9,000
	A	1,257	0	47,630	4,409	53,296	0	53,296	68,800
	Total	2,666	0	47,924	5,154	55,744	0	55,744	77,800
2007	P	1,734	0	10	2,414	4,158	0	4,158	5,000
	A	496	0	43,161	4,426	48,084	0	48,084	68,800
	Total	2,230	0	43,171	6,840	52,242	0	52,242	73,800
2008	P	1,503	0	35	1,473	3,012	0	3,012	2,500
	A	187	0	38,831	2,738	41,756	0	41,756	68,800
	Total	1,690	0	38,866	4,212	44,767	0	44,767	71,300
2009	P	1,256	0	70	519	1,844	0	1,844	2,500
	A	94	0	44,780	1,939	46,812	0	46,812	65,000
	Total	1,349	0	44,850	2,457	48,657	0	48,657	67,500
2010	P	769	5	2	595	1,370	0	1,370	2,000
	A	386	297	42,458	4,154	47,295	0	47,295	65,000
	Total	1,155	302	42,460	4,749	48,666	0	48,666	67,000
2011	P	833	0	21	664	1,518	0	1,518	2,000
	A	210	0	36,882	1,372	38,464	0	38,464	65,000
	Total	1,043	0	36,903	2,036	39,982	0	39,982	67,000
2012	P	265	5	68	262	599	0	599	2,000
prelim.	A	152	223	31,820	381	32,576	0	32,576	43,500
	Total	416	228	31,887	643	33,175	0	33,175	45,500
2013	P	874	180	1	649	1,703	0	1,703	2,000
prelim.	A	24	3,025	29,911	1,409	34,368	0	34,368	43,500
	Total	898	3,205	29,912	2,057	36,072	0	36,072	45,500

Table 4a. Annual landings (t) of 4T herring for the spring spawning group by fleet and corresponding TACs, 1996 to 2013.

	Landings (t)				Gillnet	Seiner
Year	Gillnet	Seiner	Total	% gillnet	TAC (t)	TAC (t)
1996	16,775	5,452	22,226	75	11,638	3,476
1997	12,943	4,473	17,416	74	12,705	3,795
1998	13,503	1,718	15,220	89	12,705	3,795
1999	10,432	4,457	14,889	70	14,245	4,255
2000	15,292	2,334	17,626	87	12,705	3,795
2001	10,674	3,446	14,120	76	9,625	2,875
2002	8,815	1,124	9,939	89	6,160	1,840
2003	8,496	490	8,986	95	8,470	2,530
2004	7,792	431	8,223	95	10,395	3,105
2005	3,585	1,084	4,669	77	8,470	2,530
2006	1,703	745	2,447	70	6,930	2,070
2007	1,744	2,414	4,158	42	3,851	1,149
2008	1,538	1,473	3,012	51	1,921	579
2009	1,326	519	1,844	72	1,921	579
2010	771	600	1,371	56	1,537	463
2011	854	664	1,518	56	1,537	463
2012	333	267	600	56	1,537	463
2013	875	829	1,704	51	1,537	463
Mean 2009 - 2013	832	576	1,407	58	1,614	486

Table 4b. Annual landings (t) of 4T herring for the fall spawning group by fleet and corresponding TACs, 1996 to 2013.

	Landings (t)				Gillnet	Seiner
Year	Gillnet	Seiner	Total	% gillnet	TAC (t)	TAC (t)
1996	45,075	8,744	53,819	84	52,976	15,824
1997	35,354	6,363	41,717	85	45,237	13,512
1998	39,537	3,914	43,451	91	38,500	11,500
1999	46,240	9,464	55,704	83	44,327	13,241
2000	51,272	6,911	58,183	88	46,585	13,915
2001	45,445	7,923	53,368	85	54,670	16,330
2002	42,256	11,362	53,618	79	46,585	13,915
2003	48,374	12,839	61,213	79	39,655	11,845
2004	36,277	7,121	43,398	84	47,740	14,260
2005	52,640	7,756	60,396	87	56,210	16,790
2006	48,887	4,409	53,296	92	53,018	15,782
2007	43,657	4,426	48,084	91	53,018	15,782
2008	39,017	2,738	41,756	93	53,018	15,782
2009	44,874	1,939	46,812	96	50,090	14,910
2010	42,844	4,451	47,295	91	50,090	14,910
2011	37,092	1,372	38,464	96	50,090	14,910
2012	31,972	604	32,576	98	33,522	9,978
2013	29,935	4,434	34,369	87	33,522	9,978
Mean 2009 - 2013	37,343	2,560	39,903	94	43,463	12,937

Table 5. Number of respondents by area homeport and area of fishing activity for spring gillnetters contacted during the telephone survey for 2012 and 2013. See Fig. 5 for area locations.

	Fishing Location								
Home Port	Mag. Is.	Quebec	Ac. Pen.	Escuminac	Se N.B.	N.S.	E.P.E.I	W.P.E.I.	Total
2012									
Mag. Is.	3	-	-	-	-	-	-	-	3
Quebec	-	16	-	-	-	-	-	-	16
Ac. Pen.	-	-	1	-	-	-	-	-	1
Escuminac	-	-	-	0	-	-	-	-	0
Se N.B.	-	-	-	-	1	-	-	-	1
N.S.	-	-	-	-	-	1	-	-	1
E.P.E.I.	-	-	-	-	-	-	1	-	1
W.P.E.I.	-	-	-	-	-	-	-	4	4
Total	3	16	1	0	1	1	1	4	27
2013									
Mag. Is.	2	-	-	-	-	-	-	-	2
Quebec	-	12	-	-	-	-	-	-	12
Ac. Pen.	-	-	2	-	-	-	-	-	2
Escuminac	-	-	-	1	1	-	-	-	2
Se N.B.	-	-	-	-	4	-	-	-	4
N.S.	-	-	-	-	-	1	-	-	1
E.P.E.I.	-	-	-	-	-	-	-	-	0
W.P.E.I.	-	-	-	-	1	-	-	4	5
Total	2	12	2	1	6	1	0	4	28

Table 6. Number of respondents by area homeport and area of fishing activity for fall gillnetters contacted during the telephone survey for 2012 and 2013. See Fig. 5 for area locations.

	Fishing Location								
Home Port	Mag. Is.	Quebec	Ac. Pen.	Escuminac	Se N.B.	N.S.	E.P.E.I	W.P.E.I.	Total
2012									
Mag. Is.	0	-	-	-	-	-	-	-	0
Quebec	-	43	-	-	-	-	-	-	43
Ac. Pen.	-	-	33	5	-	-	-	6	44
Escuminac	-	-	-	2	-	-	-	2	4
Se N.B.	-	-	-	2	1	-	-	1	4
N.S.	-	-	-	-	-	26	-	-	26
E.P.E.I.	-	-	-	-	-	-	17	-	17
W.P.E.I.	-	-	-	-	-	-	4	11	15
Total	0	43	33	9	1	26	21	20	153
2013									
Mag. Is.	0	-	-	-	-	-	-	-	0
Quebec	-	46	-	-	-	-	-	-	46
Ac. Pen.	-	-	36	4	-	-	-	4	44
Escuminac	-	-	-	5	-	-	-	4	9
Se N.B.	-	-	-	-	0	-	-	-	0
N.S.	-	-	-	-	-	30	-	-	30
E.P.E.I.	-	-	-	-	-	-	20	-	20
W.P.E.I.	-	-	-	1	-	-	1	9	11
Total	0	46	36	10	0	30	21	17	160

Table 7. Average length of gillnets (fathoms) and percent distribution of gillnet types from the telephone survey used in the 2012 and 2013 herring fisheries. See Fig. 5 for area locations.

	Spring			Fall		
Area	Length	*Set %	*Modified %	Length	Set %	Modified %
2012						
Mag. Is.	15.0	100	0	-	-	-
Quebec	14.3	100	0	14.3	32	68
Ac. Pen.	13.0	100	0	14.2	21	79
Escuminac	-	-	-	14.8	84	16
Se N.B.	15.0	100	0	15.0	100	0
N.S.	-	-	-	15.6	96	4
E.P.E.I.	15.0	100	0	13.5	100	0
W.P.E.I.	12.5	100	0	14.2	85.5	14.5
2013						
Mag. Is.	13.0	100	0	-	-	-
Quebec	14.3	100	0	13.7	36	64
Ac. Pen.	12.0	100	0	13.8	23	77
Escuminac	15.0	100	0	14.4	95	5
Se N.B.	13.9	100	0	-	-	-
N.S.	15.0	100	0	15.1	98	2
E.P.E.I.	-	-	-	13.7	100	0
W.P.E.I.	11.8	100	0	13.9	100	0

* Set = anchored at both ends; Modified = one end attached to boat

Table 8. Telephone survey percent of fishing days with no gillnet catch for main fishing areas. See Fig. 5 for area locations.

Year	Spring Areas 1,2,3,4,5,8 (%)	Fall Areas 2,3,4,6,7,8 (%)
2006	46.7	16.7
2007	40.0	28.8
2008	49.4	28.8
2009	23.2	17.5
2010	34.1	19.9
2011	26.2	27.3
2012	43.1	24.2
2013	36.3	22.8

Table 9a. Characteristics of the gillnet fishing effort for 2012 and 2013 during the spring season by area, obtained from the telephone survey and collected by the dockside monitoring program (DMP) where available. Length is expressed in fathoms; N = number of respondents with information; na means no data or not applicable.

		2012 Telephone survey			2012 DMP			2013 Telephone survey			2013 DMP		
Area	Gillnet characteristics	Mean	N	Std. error	Mean	N	Std. error	Mean	N	Std. error	Mean	N	Std. error
Magdalen Islands	Number	14.3	3	2.7	11.8	28	0.4	12	2	0	11.4	8	0.5
	Length (fa)	15	3	0	na	na	na	13	2	2	na	na	na
	Depth (Meshes)	100	3	0	na	na	na	93.5	2	6.5	na	na	na
Quebec	Number	14.8	13	1.7	19	3	1	18.2	11	1.6	16.6	11	1.2
	Length (fa)	14.3	15	0.5	na	na	na	14.3	11	0.6	na	na	na
	Depth (Meshes)	77.5	15	5.1	na	na	na	92.9	11	2.4	na	na	na
Acadian Peninsula	Number	20.5	2	2.5	17	3	2.3	18.7	3	3.8	15.9	9	1.2
	Length (fa)	13	2	1	13.3	3	1.2	12	3	0	14.2	9	0.3
	Depth (Meshes)	55	2	5	na	na	na	58.3	3	8.3	na	na	na
Escuminac	Number	na	na	na	15.5	2	5.5	21	1	na	21.5	3	0.6
	Length (fa)	na	na	na	na	na	na	15	1	na	14.4	3	0.1
	Depth (Meshes)	na	na	na	na	na	na	80	1	na	na	na	na
SE New Brunswick	Number	21	1	na	19.1	3	0.9	19.6	5	3.2	20.1	25	0.8
	Length (fa)	15	1	na	13.8	3	0.9	13.9	6	0.6	14.6	0.1	0.1
	Depth (Meshes)	60	1	na	na	na	na	68.3	6	4	na	na	na
Nova Scotia	Number	na	na	na	na	na	na	na	na	na	na	na	na
	Length (fa)	na	na	na	na	na	na	na	na	na	na	na	na
	Depth (Meshes)	na	na	na	na	na	na	na	na	na	na	na	na
East PEI	Number	17	1	na	13.5	3	2.3	na	na	na	11.2	3	2
	Length (fa)	15	1	na	13.7	3	0.7	na	na	na	15.3	3	0.3
	Depth (Meshes)	80	1	na	na	na	na	na	na	na	na	na	na
West PEI	Number	22.8	4	3	19.9	20	0.39	20	3	1.2	17.7	28	0.5
	Length (fa)	12.5	4	0.2	13.5	20	0.23	11.8	4	0.6	12.2	28	0.05
	Depth (Meshes)	44.3	4	1.7	na	na	na	55	4	8.7	na	na	na

Table 9b. Characteristics of the gillnet fishing effort for 2012 and 2013 during the fall season by area, obtained from the telephone survey and collected by the dockside monitoring program (DMP) where available. Length is expressed in fathoms; N = number of respondents with information; na means no data or not applicable.

		2012 Telephone survey			2012 DMP			2013 Telephone survey			2013 DMP		
Area	Gillnet characteristics	Mean	N	Std. error	Mean	N	Std. error	Mean	N	Std. error	Mean	N	Std. error
Magdalen Islands	Number	na	na	na	na	na	na	na	na	na	na	na	na
	Length (fa)	na	na	na	na	na	na	na	na	na	na	na	na
	Depth (Meshes)	8.1	42	0.3	10	2	na	8	34	0.3	na	na	na
Quebec	Number	14.3	43	0.3	na	na	na	13.7	46	0.2	na	na	na
	Length (fa)	117	42	0.4	na	na	na	114.9	42	1.9	na	na	na
	Depth (Meshes)	8.3	37	0.3	8.1	26	0.27	8.3	41	0.2	9.3	8	0.7
Acadian Peninsula	Number	14.2	38	0.3	14.1	26	0.17	13.8	42	0.2	13.2	8	0.3
	Length (fa)	117.8	38	1.8	na	na	na	116.9	40	1.8	na	na	na
	Depth (Meshes)	8.5	8	0.4	8.8	46	0.36	8.9	7	0.7	8.9	38	0.3
Escuminac	Number	14.8	10	0.5	14	46	0.14	14.4	10	0.3	13.1	38	0.1
	Length (fa)	99.4	10	2.6	na	na	na	98.9	9	1.1	na	na	na
	Depth (Meshes)	9	1	na	6.7	6	0.39	na	na	na	9.2	5	0.4
SE New Brunswick (July)	Number	15	1	na	na	na	na	na	na	na	12.9	5	0.3
	Length (fa)	80	1	na	na	na	na	na	na	na	na	na	na
	Depth (Meshes)	6	26	0.3	6.7	27	0.09	5.6	29	0.1	6.3	6	0.8
Nova Scotia	Number	15.6	26	0.3	16.1	27	0.17	15.1	30	0.4	15.1	6	0.08
	Length (fa)	93.7	25	4.2	na	na	na	89.5	30	0.6			
	Depth (Meshes)	9	18	0.6	8.5	122	0.1	9.2	20	0.2	9.0	107	0.2
East PEI	Number	13.5	21	0.4	13.6	122	0.09	13.7	21	0.3	14.3	107	0.1
	Length (fa)	90.8	19	4.4	na	na	na	90	19	6	na	na	na
	Depth (Meshes)	8.7	19	0.3	9.5	69	0.25	8.6	16	0.6	9.1	67	0.2
West PEI	Number	14.2	20	0.4	13.4	69	0.1	13.9	17	0.4	12.9	67	0.1
	Length (fa)	83.3	20	5.6	na	na	na	89.7	17	4.3	na	na	na
	Depth (Meshes)	na	na	na	na	na	na	na	na	na	na	na	na

Table 10. Comparison of ages obtained by the primary reader during the validation test with the original ages assigned.

Original Age	Age in 2013											Total aged
	1	2	3	4	5	6	7	8	9	10	11	
1	5	-	-	-	-	-	-	-	-	-	-	5
2	-	16	-	-	-	-	-	-	-	-	-	16
3	-	-	25	1	-	-	-	-	-	-	-	26
4	-	-	2	26	1	-	-	-	-	-	-	29
5	-	-	-	2	52	-	-	-	-	-	-	54
6	-	-	-	-	1	17	2	-	-	-	-	20
7	-	-	-	-	-	1	23	-	-	-	-	24
8	-	-	-	-	-	-	1	21	1	-	-	23
9	-	-	-	-	-	-	-	-	5	-	-	5
10	-	-	-	-	-	-	-	-	1	3	-	4
11	-	-	-	-	-	-	-	-	-	2	2	4
Total	5	16	27	29	54	18	26	21	7	5	2	210

% agreement = 92.9 (CV = 1.92)

Table 11. Acoustic survey estimates in terms of total numbers and biomass, at age by area derived from acoustic signal and samples from midwater trawling during the 2012 and 2013 surveys. PEI was not surveyed in 2013.

	Number of fish (X 1000)			Biomass (t)		
	Gaspe-Chaleur-Miscou		PEI	Gaspe-Chaleur-Miscou		PEI
Age	2012	2013	2012	2012	2013	2012
Spring spawners						
0	0	0	0	0	0	0
1	1,398	0	0	0	0	0
2	29,739	21,561	3,238	469	45	287
3	38,542	41,093	1,115	12,124	1,078	144
4	39,988	15,998	0	3,501	3,043	0
5	8,136	16,946	0	1,364	3,548	0
6	8,469	8,716	1,326	1,130	2,466	270
7	3,930	4,525	0	544	967	0
8	2,433	117	0	379	297	0
9	1,517	2,112	0	49	0	0
10	0	119	0	140	0	0
11	0	1,348	0	0	0	0
Total	134,152	112,534	5,679	19,758	11,446	702
Fall spawners						
1	0	0	0	0	0	0
2	597	4,291	0	40	325	0
3	272,487	19,522	22,840	27,495	2,145	2,030
4	115,529	173,640	15,441	13,762	22,296	1,626
5	103,831	70,651	10,032	13,873	10,218	1,254
6	56,154	99,150	28,064	8,485	15,775	3,949
7	19,331	41,748	22,048	3,301	7,447	3,400
8	1,474	10,858	4,187	258	2,009	725
9	2,789	7,683	2,505	369	1,517	455
10	283	11,321	0	48	2,355	0
11	0	0	0	0	0	0
Total	573,824	438,864	105,116	67,634	64,083	13,434
Spring and fall spawners						
Total	707,976	551,398	110,795	87,393	75,529	14,136
% Spring	18.9	20.4	5.1	22.6	15.2	5.0

Table 12a. Correlation of age-class abundance from one year (cpue) to the next (cpue1), 2 year (cpue2) and 3 year (cpue3) lags for spring spawning herring based on data from the same area sampled in the Chaleurs-Miscou acoustic survey since 1994.

			Number of fish			Log of number of fish		
Age	Variable 1	Variable 2	correlation	n	p value	correlation	n	p value
3	cpue	cpue1	0.76	19	0.0001	0.60	19	0.0067
4	cpue	cpue1	0.51	19	0.0265	0.51	19	0.0274
5	cpue	cpue1	0.85	19	0.0000	0.63	19	0.0038
6	cpue	cpue1	0.80	19	0.0000	0.79	18	0.0001
7	cpue	cpue1	0.74	19	0.0003	0.51	16	0.0415
8	cpue	cpue1	0.85	19	0.0000	0.84	14	0.0002
9	cpue	cpue1	0.60	19	0.0061	0.13	11	0.6938
3	cpue	cpue2	0.82	18	0.0000	0.49	18	0.0393
4	cpue	cpue2	0.63	18	0.0052	0.54	18	0.0203
5	cpue	cpue2	0.98	18	0.0000	0.76	17	0.0004
6	cpue	cpue2	0.94	18	0.0000	0.64	16	0.0073
7	cpue	cpue2	0.58	18	0.0117	0.67	12	0.0180
8	cpue	cpue2	0.60	18	0.0078	0.16	10	0.6539
3	cpue	cpue3	0.78	17	0.0002	0.57	17	0.0176
4	cpue	cpue3	0.47	17	0.0561	0.57	16	0.0203
5	cpue	cpue3	0.94	17	0.0000	0.62	15	0.0142
6	cpue	cpue3	0.78	17	0.0002	0.65	12	0.0222
7	cpue	cpue3	0.60	17	0.0113	0.54	9	0.1351

Table 12b. Correlation of age-class abundance from one year (cpue) to the next (cpue1), 2 year (cpue2) and 3 year (cpue3) lags for fall spawning herring based on data from the same area sampled in the Chaleurs-Miscou acoustic survey since 1994.

			Number of fish			Log of number of fish		
Age	Variable 1	Variable 2	correlation	n	p value	correlation	n	p value
3	cpue	cpue1	0.33	19	0.1707	0.45	19	0.0509
4	cpue	cpue1	0.30	19	0.2135	0.42	19	0.0740
5	cpue	cpue1	0.43	19	0.0661	0.47	19	0.0424
6	cpue	cpue1	0.61	19	0.0057	0.45	19	0.0558
7	cpue	cpue1	0.66	19	0.0022	0.19	19	0.4339
8	cpue	cpue1	0.34	19	0.1554	0.30	18	0.2337
9	cpue	cpue1	0.49	19	0.0318	0.60	17	0.0107
3	cpue	cpue2	0.26	18	0.3060	0.26	18	0.3068
4	cpue	cpue2	0.18	18	0.4813	0.49	18	0.0378
5	cpue	cpue2	0.28	18	0.2594	0.37	18	0.1357
6	cpue	cpue2	0.57	18	0.0137	0.13	18	0.6152
7	cpue	cpue2	0.46	18	0.0552	0.19	17	0.4652
8	cpue	cpue2	0.40	18	0.0986	0.62	18	0.0062
3	cpue	cpue3	0.25	17	0.3399	0.37	17	0.1419
4	cpue	cpue3	0.31	17	0.2230	0.57	17	0.0177
5	cpue	cpue3	0.30	17	0.2485	0.53	17	0.0277
6	cpue	cpue3	0.22	17	0.3980	0.00	16	0.9872
7	cpue	cpue3	0.21	17	0.4228	0.19	17	0.4769

Table 13. Spring fishery samples and landings by zone used to derive 2012 and 2013 catch and weight-at-age matrices for 4T herring.

Gear and Region	Fishery	Zone	Number of samples	Landings (t)
2012				
FIXED GEAR GILLNETS				
North	Gaspe - Chaleur (16AB) April-May	4Tmnopq	2	194.5
North	Gaspe - Chaleur (16AB) June	4Tmnopq	2	127.5
Middle	Escuminac (16C) - WP.E.I.(16E) April – May	4Tl	3	6.5
South	Magdalen Islands (16D) April – June	4Tf	0*	2.7
South	East P.E.I. – N.S. (16FG) April – June	4Tgj	4	39.4
South	SE N.B. - South P.E.I. - N.S. (16EF) April - June	4Th	5	45.6
Fixed gear total		4T	16	416.2
MOBILE GEAR PURSE SEINES				
South	Edge Cabot (16D) May – June	4Tf	6	228.0
Mobile Gear total		4T	6	228.0
2013				
FIXED GEAR GILLNETS				
North	Gaspé (16A) April – June	4Topq	1	6.3
North	Chaleur (16B) April	4Tmn	4	302.3
North	Chaleur (16B) May – June	4Tmn	2	72.6
Middle	Escuminac (16C) – W P.E.I.(16E) April – June	4Tl	4	22.0
South	Magdalen Islands (16D) April - June	4Tf	0*	3.3
South	East P.E.I. – N.S. (16FG) April – June	4Tgj	4	42.9
South	SE N.B.-South P.E.I.-N.S. (16E) April 21-27	4Th	5	349.8
South	SE N.B.-South P.E.I.-N.S. (16E) April 28 - June	4Th	2	99.3
Fixed gear total		4T	22	898.6
MOBILE GEAR PURSE SEINES				
South	Edge Cabot (16D) May – June	4Tf	5	3204.0
Mobile Gear total		4T	5	3204.0

** used samples from all of 4Th*

Table 14a. Spring spawner catch-at-age (number of fish, X 1000) for 4T herring from the fixed gear fishery, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1978	0	44	6026	25253	1042	2123	660	243	370	1561	752	38072
1979	100	112	7352	2544	17558	540	842	127	127	327	1421	31050
1980	0	217	9420	6744	2378	9068	1424	807	612	442	720	31832
1981	3	438	11843	7099	1941	1399	3052	415	422	171	882	27664
1982	11	216	23577	4191	988	421	299	315	143	88	618	30868
1983	0	155	13547	26208	2142	472	76	0	0	8	0	42608
1984	16	39	3377	12083	7529	409	59	14	7	4	0	23538
1985	0	39	4921	12685	13742	4630	614	100	32	71	0	36833
1986	0	11	2712	13905	12357	10348	2783	391	20	233	349	43109
1987	0	10	1232	6164	20071	11410	9674	4080	947	512	258	54357
1988	60	549	3536	6298	9353	14600	6944	5246	935	68	269	47859
1989	0	0	3941	15672	4836	4912	6957	4326	2598	1025	279	44546
1990	0	128	1925	7387	4109	2178	2532	3928	1827	733	306	25053
1991	0	0	6070	11715	14140	9142	3166	2897	4448	1640	1097	54314
1992	0	0	2160	30046	11543	7579	3460	1593	1956	1423	2263	62023
1993	0	8	231	5488	40374	18381	4900	2409	1375	708	2724	76597
1994	0	0	2061	5847	24642	48553	9048	3595	1221	438	1032	96438
1995	0	0	200	13345	10782	17781	28929	6408	1788	1156	2271	82661
1996	0	0	416	1682	48104	9123	14154	9414	3102	590	1087	87672
1997	0	2	107	5440	4069	37818	6961	4149	3938	1015	179	63678
1998	0	0	785	7744	15786	2264	29871	3421	2449	1966	875	65159
1999	0	89	1724	6599	9410	10297	2255	16045	2583	1342	1155	51499
2000	0	12	2141	11977	15975	15248	7568	4457	11675	2912	1756	73722
2001	0	0	910	11316	13082	9859	4920	3360	1387	6593	1735	53163
2002	0	1	2509	7044	18352	7626	3608	2075	1152	1052	1214	44633
2003	0	0	285	10766	11071	12832	3925	2483	998	686	759	43803
2004	0	21	1607	2606	15101	5400	8500	3223	1164	413	1005	39040
2005	0	0	72	3639	3209	5784	2561	2023	566	125	174	18153
2006	0	1	720	1299	4653	1652	528	285	387	28	73	9626
2007	0	1	864	2037	1563	2323	1738	803	196	149	110	9784
2008	0	71	177	2812	3111	1139	1261	269	52	23	12	8928
2009	0	23	411	1060	2445	3033	344	349	91	6	14	7775
2010	0	0	183	933	661	1132	590	292	304	2	9	4106
2011	0	0	30	162	825	752	1000	489	758	262	8	4285
2012	0	0	138	269	183	309	455	219	161	150	64	1948
2013	0	0	5	202	727	998	1268	1001	723	38	35	4997

Table 14b. Spring spawner mean weight-at-age (kg) for 4T herring from the fixed gear fishery, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Mean
1978	-	0.1542	0.1482	0.1866	0.2154	0.2513	0.2825	0.3180	0.3080	0.3373	0.3644	0.1983
1979	0.0199	0.1614	0.1628	0.1975	0.2262	0.2427	0.3125	0.3351	0.3515	0.3262	0.3601	0.2188
1980	-	0.1841	0.1669	0.1887	0.2314	0.2784	0.3040	0.3341	0.3588	0.3689	0.3787	0.2299
1981	0.0274	0.1556	0.1782	0.2324	0.2667	0.3184	0.3428	0.3505	0.3738	0.4108	0.4191	0.2379
1982	0.0379	0.1865	0.1732	0.2070	0.2614	0.3111	0.3699	0.3853	0.3958	0.4159	0.4494	0.1939
1983	-	0.1696	0.1481	0.2056	0.2361	0.2585	0.3428	-	-	0.3606	-	0.1896
1984	0.0630	0.1044	0.1740	0.1957	0.2166	0.2891	0.3399	0.4042	0.4901	0.3686	-	0.2013
1985	-	0.2127	0.1695	0.1984	0.2292	0.2660	0.3152	0.3146	0.3294	0.4317	-	0.2174
1986	-	0.1108	0.1833	0.2104	0.2423	0.2606	0.3070	0.3477	0.3360	0.3642	0.3923	0.2397
1987	-	0.0905	0.1918	0.1962	0.2184	0.2494	0.2670	0.2805	0.3166	0.3096	0.3774	0.2384
1988	0.0398	0.0800	0.1601	0.1967	0.2373	0.2654	0.2903	0.3074	0.3350	0.3689	0.3595	0.2509
1989	-	-	0.1647	0.2023	0.2293	0.2574	0.2907	0.3007	0.3141	0.3280	0.3001	0.2414
1990	-	0.1531	0.1688	0.2028	0.2409	0.2730	0.2971	0.2901	0.3114	0.3219	0.3394	0.2486
1991	-	-	0.1463	0.1819	0.2190	0.2460	0.2597	0.2917	0.3025	0.3197	0.3191	0.2256
1992	-	-	0.1446	0.1717	0.2011	0.2315	0.2553	0.2742	0.2908	0.2986	0.3317	0.2034
1993	-	0.1347	0.1272	0.1638	0.1862	0.2070	0.2438	0.2519	0.2684	0.2941	0.2917	0.2014
1994	-	-	0.1408	0.1561	0.1773	0.2002	0.2182	0.2489	0.3141	0.2722	0.3042	0.1968
1995	-	0.1160	0.1822	0.1598	0.1789	0.2021	0.2218	0.2449	0.2712	0.3007	0.3217	0.2086
1996	-	-	0.1571	0.1819	0.1727	0.1928	0.2090	0.2334	0.2305	0.2753	0.2769	0.1913
1997	-	0.1331	0.1309	0.1621	0.1828	0.2005	0.2128	0.2327	0.2464	0.2458	0.3032	0.2033
1998	-	-	0.1366	0.1612	0.1850	0.2058	0.2205	0.2403	0.2459	0.2573	0.2783	0.2072
1999	-	0.1206	0.1203	0.1494	0.1757	0.2037	0.2204	0.2304	0.2438	0.2543	0.2691	0.2026
2000	-	0.1135	0.1315	0.1581	0.1838	0.2072	0.2251	0.2504	0.2534	0.2618	0.2728	0.2074
2001	-	-	0.1347	0.1581	0.1820	0.1982	0.2230	0.2358	0.2571	0.2598	0.2698	0.2008
2002	-	0.0978	0.1407	0.1648	0.1877	0.2046	0.2269	0.2511	0.2700	0.2794	0.2893	0.1975
2003	-	-	0.1433	0.1604	0.1840	0.2023	0.2226	0.2326	0.2533	0.2596	0.2800	0.1939
2004	-	0.1297	0.1343	0.1493	0.1779	0.2031	0.2285	0.2380	0.2539	0.2615	0.2878	0.1996
2005	-	0.0754	0.1345	0.1520	0.1723	0.2011	0.2209	0.2524	0.2530	0.2692	0.3084	0.1975
2006	-	0.1202	0.1318	0.1465	0.1688	0.1960	0.2208	0.2456	0.2481	0.2926	0.2421	0.1769
2007	-	0.1081	0.1392	0.1520	0.1686	0.1854	0.1944	0.2119	0.2530	0.2457	0.2342	0.1783
2008	-	0.1369	0.1437	0.1579	0.1641	0.1813	0.2027	0.2375	0.2403	0.2685	0.2975	0.1723
2009	-	0.1184	0.1440	0.1548	0.1652	0.1732	0.2052	0.2093	0.2531	0.2230	0.2063	0.1705
2010	-	-	0.1325	0.1556	0.1653	0.1956	0.2145	0.2339	0.2380	0.2632	0.2777	0.1876
2011	-	-	0.1179	0.1517	0.1721	0.1806	0.1990	0.2179	0.2316	0.2491	0.2464	0.1993
2012	-	-	0.1590	0.1440	0.1440	0.1554	0.1699	0.1880	0.1894	0.2272	0.2208	0.1705
2013	-	-	0.1171	0.1345	0.1477	0.1606	0.1813	0.1866	0.2034	0.2171	0.2236	0.1751

Table 15a. Spring spawner catch-at-age (number of fish, X 1000) for 4T herring from the mobile gear fishery, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1978	1390	14933	3664	24366	3053	4619	1293	734	565	2877	599	58093
1979	11644	14535	4553	4800	25927	4014	6971	2139	1638	1501	12300	90021
1980	737	11101	10404	1790	1878	11154	8852	4207	2229	751	286	53389
1981	0	362	1105	939	9	881	347	699	264	417	7	5031
1982	0	2343	3816	400	53	10	89	165	210	2	19	7109
1983	0	1349	8017	3838	449	1	65	71	89	0	0	13878
1984	0	619	1831	4190	2901	291	0	71	41	0	0	9943
1985	601	1132	4581	2451	3085	1153	77	0	0	0	294	13373
1986	0	4194	3982	9551	7647	7410	3070	212	514	0	60	36640
1987	0	1476	1977	2945	10495	7260	7060	3696	0	0	93	35002
1988	2710	6291	2125	1546	2730	11772	9514	5399	2434	0	2155	46676
1989	374	425	2982	4949	1644	4682	10289	4223	2285	430	118	32401
1990	46	5182	6250	7301	4236	2645	1504	5841	2964	737	318	37024
1991	32	1825	9393	3064	2640	1271	654	1000	890	653	1307	22730
1992	5	860	2808	7350	3461	2489	707	448	790	527	453	19896
1993	35	3093	2374	6696	5403	2662	1577	974	1309	902	2289	27315
1994	0	52	4057	2255	3477	5930	2435	1349	647	166	1251	21620
1995	0	1418	1588	17081	5809	4899	7749	1675	1024	280	1708	43231
1996	6	385	2942	919	11291	3589	2107	1965	370	388	138	24100
1997	83	419	1405	3457	1246	7719	911	1610	1444	146	466	18906
1998	5	298	796	1930	1524	213	1767	461	337	374	254	7959
1999	267	1771	2841	4854	3057	1516	933	2949	987	480	579	20234
2000	294	1314	3254	3739	1485	891	354	305	491	70	92	12290
2001	557	4259	3721	4852	2521	1130	1157	448	195	288	148	19276
2002	55	744	3135	1060	729	195	554	109	42	7	42	6671
2003	26	209	654	869	327	279	270	9	5	40	22	2709
2004	103	487	825	433	360	135	234	17	10	1	17	2621
2005	372	1814	1859	2572	259	335	52	0	70	0	0	7333
2006	61	236	898	521	1825	620	138	24	6	5	0	4333
2007	524	3651	3605	2396	1786	2368	700	256	15	0	113	15414
2008	268	3474	1888	765	1209	587	774	137	93	16	28	9239
2009	7	441	1670	227	171	172	441	17	0	173	38	3358
2010	0	116	406	941	506	713	634	74	8	0	1	3398
2011	19	629	814	669	682	577	576	73	106	356	23	4525
2012	0	18	408	459	282	240	171	9	34	0	21	1641
2013	6	185	542	1359	1123	693	535	352	64	0	18	4878

Table 15b. Spring spawner mean weight-at-age (kg) for 4T herring from the mobile gear fishery, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Mean
1978	0.0784	0.1305	0.1822	0.2622	0.2479	0.2807	0.3014	0.3084	0.3522	0.3807	0.3894	0.2291
1979	0.1069	0.1734	0.1931	0.2121	0.2613	0.2586	0.3033	0.3048	0.3397	0.3420	0.3641	0.2420
1980	0.1144	0.1585	0.1653	0.2172	0.2619	0.2731	0.2581	0.2645	0.2752	0.3642	0.3410	0.2223
1981	0.0274	0.1578	0.2025	0.2741	0.2716	0.4250	0.3063	0.2838	0.2900	0.3156	0.4168	0.2845
1982	0.0379	0.1325	0.2251	0.2655	0.2529	0.3154	0.4634	0.3081	0.3394	0.4360	0.4505	0.2061
1983	-	0.1445	0.1881	0.2314	0.2775	0.2695	0.3151	0.2433	0.4110	-	-	0.2011
1984	0.0630	0.1214	0.1920	0.2294	0.2621	0.2908	0.3000	0.3798	0.3511	0.3756	-	0.2287
1985	0.0828	0.1373	0.2213	0.2439	0.2973	0.3129	0.3836	-	-	-	0.3837	0.2420
1986	-	0.1442	0.1959	0.2487	0.2829	0.3146	0.3387	0.3491	0.3150	-	0.3921	0.2608
1987	-	0.1559	0.1892	0.2511	0.3041	0.3317	0.3585	0.3746	-	-	0.5265	0.3116
1988	0.0816	0.1149	0.1756	0.2510	0.3008	0.3370	0.3393	0.3932	0.4122	-	0.4416	0.2957
1989	0.0898	0.1415	0.2122	0.2583	0.2703	0.3125	0.3427	0.3625	0.3847	0.4112	0.4660	0.3111
1990	0.0784	0.1726	0.1966	0.2461	0.2805	0.2943	0.3333	0.3416	0.3516	0.4090	0.3631	0.2659
1991	0.0815	0.1433	0.1805	0.2153	0.2482	0.2642	0.3217	0.3343	0.3568	0.3488	0.4008	0.2299
1992	0.0558	0.1169	0.1475	0.2004	0.2409	0.2724	0.2923	0.3232	0.3266	0.3376	0.3849	0.2242
1993	0.0699	0.1091	0.1518	0.1789	0.1948	0.2349	0.2517	0.2895	0.2813	0.3114	0.3473	0.2087
1994	-	0.1445	0.1559	0.1882	0.2073	0.2339	0.2584	0.2694	0.2741	0.3159	0.3305	0.2224
1995	-	0.1052	0.1461	0.1818	0.2024	0.2265	0.2471	0.2785	0.3033	0.3144	0.3150	0.2103
1996	0.0733	0.1157	0.1692	0.2054	0.2244	0.2329	0.2463	0.2764	0.3245	0.2999	0.3784	0.2262
1997	0.0679	0.1239	0.1549	0.1916	0.2088	0.2490	0.2712	0.2869	0.3082	0.3286	0.3258	0.2366
1998	0.0760	0.1093	0.1451	0.1710	0.2168	0.2033	0.2477	0.2629	0.2789	0.2960	0.4023	0.2158
1999	0.0627	0.1183	0.1562	0.1875	0.2321	0.2650	0.2773	0.2937	0.3085	0.3171	0.3186	0.2203
2000	0.0682	0.1314	0.1593	0.1864	0.2185	0.2475	0.2766	0.2925	0.2936	0.2836	0.3320	0.1899
2001	0.0620	0.1176	0.1485	0.1896	0.2094	0.2425	0.2564	0.2960	0.3272	0.3296	0.3231	0.1787
2002	0.0606	0.1057	0.1491	0.1756	0.2056	0.2133	0.2509	0.2810	0.2883	0.2875	0.3286	0.1685
2003	0.0778	0.0989	0.1408	0.1766	0.1987	0.2377	0.2507	0.2817	0.2910	0.2955	0.3300	0.1810
2004	0.0681	0.1100	0.1457	0.1616	0.2090	0.2306	0.2513	0.3000	0.3136	0.2900	0.3666	0.1643
2005	0.0785	0.1200	0.1453	0.1629	0.1877	0.2097	0.1976	-	0.2609	-	-	0.1477
2006	0.0629	0.1103	0.1450	0.1714	0.1789	0.2034	0.2344	0.3003	0.3502	0.2860	-	0.1719
2007	0.0596	0.1176	0.1447	0.1771	0.1814	0.1974	0.1911	0.2131	0.2999	-	0.1984	0.1566
2008	0.0756	0.1285	0.1406	0.1823	0.1987	0.2065	0.2225	0.2447	0.2300	0.3495	0.2528	0.1595
2009	0.0330	0.1164	0.1388	0.1908	0.1950	0.2100	0.1717	0.2360	-	0.2006	0.2120	0.1545
2010	-	0.1092	0.1338	0.1620	0.1671	0.1998	0.2107	0.2407	0.2554	-	0.2688	0.1765
2011	0.0577	0.0831	0.1218	0.1240	0.1738	0.1686	0.1985	0.2102	0.1913	0.1637	0.1923	0.1468
2012	-	0.0832	0.1227	0.1507	0.1774	0.1837	0.2186	0.2424	0.2155	-	0.2363	0.1624
2013	0.0620	0.0962	0.1343	0.1476	0.1781	0.1966	0.2066	0.2019	0.2146	-	0.2868	0.1698

Table 16a. Spring spawner catch-at-age (number of fish, X 1000) for 4T herring from all gears combined, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1978	1390	14977	9690	49618	4095	6741	1953	977	935	4438	1350	96165
1979	11745	14647	11905	7343	43485	4553	7814	2266	1764	1828	13721	121072
1980	737	11318	19824	8534	4256	20222	10276	5014	2841	1194	1006	85221
1981	3	800	12948	8038	1950	2280	3399	1113	686	588	889	32696
1982	12	2559	27393	4591	1042	431	388	480	353	91	637	37977
1983	0	1504	21564	30046	2591	473	140	71	89	8	0	56486
1984	16	658	5208	16272	10430	700	59	85	48	4	0	33481
1985	601	1171	9501	15137	16826	5782	691	100	32	71	294	50205
1986	0	4205	6694	23456	20004	17758	5853	603	534	233	408	79749
1987	0	1486	3209	9109	30565	18670	16734	7777	947	512	351	89359
1988	2770	6840	5661	7844	12083	26372	16458	10645	3369	68	2425	94535
1989	374	425	6923	20621	6480	9594	17246	8549	4883	1455	397	76948
1990	46	5310	8175	14689	8345	4823	4036	9769	4791	1470	624	62077
1991	32	1825	15463	14779	16779	10413	3820	3897	5338	2293	2404	77044
1992	5	860	4969	37396	15003	10067	4167	2041	2745	1950	2716	81919
1993	35	3101	2605	12183	45777	21043	6477	3383	2685	1610	5013	103912
1994	0	52	6118	8102	28119	54484	11483	4945	1868	604	2282	118058
1995	0	1418	1788	30426	16591	22681	36678	8083	2812	1436	3979	125891
1996	6	385	3358	2601	59395	12712	16261	11380	3472	978	1226	111773
1997	83	420	1513	8897	5315	45537	7872	5759	5383	1161	644	82584
1998	5	298	1581	9674	17309	2477	31638	3881	2786	2339	1129	73118
1999	267	1860	4565	11453	12467	11813	3188	18994	3570	1822	1734	71733
2000	294	1326	5395	15716	17460	16139	7923	4762	12166	2982	1848	86011
2001	557	4259	4631	16168	15603	10989	6077	3808	1582	6881	1883	72440
2002	55	745	5644	8104	19080	7822	4162	2183	1193	1059	1256	51303
2003	26	209	938	11636	11398	13111	4195	2492	1002	726	780	46513
2004	103	508	2433	3038	15461	5535	8734	3240	1175	413	1022	41661
2005	372	1814	1930	6210	3468	6119	2613	2023	636	125	174	25486
2006	61	237	1618	1820	6478	2272	666	309	393	33	73	13959
2007	524	3652	4469	4433	3348	4692	2439	1059	210	149	223	25197
2008	268	3546	2065	3576	4320	1726	2035	406	146	40	41	18168
2009	7	464	2080	1286	2616	3205	785	366	91	179	52	11133
2010	0	116	590	1875	1167	1845	1224	366	312	2	9	7504
2011	19	629	844	831	1507	1329	1576	563	864	618	31	8809
2012	0	18	546	728	465	549	626	228	194	150	85	3590
2013	6	185	548	1561	1850	1690	1803	1353	788	38	53	9875

Table 16b. Spring spawner mean weight-at-age (kg) for 4T herring from all gears combined, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Mean
1978	0.0784	0.1306	0.1610	0.2237	0.2396	0.2714	0.2950	0.3108	0.3347	0.3655	0.3755	0.2169
1979	0.1061	0.1733	0.1744	0.2070	0.2471	0.2567	0.3043	0.3065	0.3406	0.3392	0.3637	0.2361
1980	0.1144	0.1590	0.1661	0.1947	0.2449	0.2755	0.2644	0.2757	0.2932	0.3659	0.3680	0.2252
1981	0.0274	0.1566	0.1803	0.2373	0.2668	0.3596	0.3390	0.3086	0.3415	0.3433	0.4191	0.2451
1982	0.0379	0.1371	0.1804	0.2121	0.2610	0.3112	0.3914	0.3588	0.3622	0.4164	0.4495	0.1962
1983	-	0.1471	0.1630	0.2089	0.2433	0.2585	0.3301	0.2433	0.4110	0.3606	-	0.1924
1984	0.0630	0.1204	0.1803	0.2044	0.2293	0.2898	0.3399	0.3838	0.3713	0.3686	-	0.2094
1985	0.0828	0.1398	0.1945	0.2058	0.2417	0.2753	0.3229	0.3146	0.3294	0.4317	0.3837	0.2240
1986	-	0.1441	0.1908	0.2260	0.2578	0.2831	0.3236	0.3482	0.3158	0.3642	0.3923	0.2494
1987	-	0.1554	0.1902	0.2139	0.2478	0.2814	0.3056	0.3252	0.3166	0.3096	0.4168	0.2670
1988	0.0807	0.1121	0.1659	0.2074	0.2517	0.2974	0.3186	0.3509	0.3908	0.3689	0.4325	0.2730
1989	0.0898	0.1415	0.1851	0.2157	0.2397	0.2843	0.3217	0.3312	0.3471	0.3526	0.3494	0.2707
1990	0.0784	0.1721	0.1901	0.2243	0.2610	0.2847	0.3106	0.3209	0.3363	0.3656	0.3515	0.2589
1991	0.0815	0.1433	0.1671	0.1889	0.2236	0.2483	0.2703	0.3026	0.3116	0.3280	0.3635	0.2268
1992	0.0558	0.1169	0.1463	0.1773	0.2103	0.2416	0.2616	0.2849	0.3011	0.3091	0.3405	0.2084
1993	0.0699	0.1092	0.1496	0.1721	0.1872	0.2105	0.2457	0.2627	0.2747	0.3038	0.3171	0.2033
1994	-	0.1445	0.1508	0.1650	0.1810	0.2039	0.2267	0.2545	0.3003	0.2842	0.3186	0.2015
1995	-	0.1052	0.1502	0.1721	0.1871	0.2074	0.2271	0.2518	0.2829	0.3034	0.3188	0.2091
1996	0.0733	0.1157	0.1677	0.1902	0.1826	0.2041	0.2138	0.2408	0.2405	0.2851	0.2883	0.1989
1997	0.0679	0.1239	0.1532	0.1735	0.1889	0.2087	0.2195	0.2479	0.2630	0.2562	0.3195	0.2109
1998	0.0760	0.1093	0.1409	0.1631	0.1878	0.2056	0.2221	0.2430	0.2499	0.2635	0.3062	0.2082
1999	0.0627	0.1184	0.1427	0.1656	0.1895	0.2116	0.2371	0.2402	0.2617	0.2709	0.2857	0.2076
2000	0.0682	0.1312	0.1482	0.1649	0.1867	0.2094	0.2274	0.2531	0.2551	0.2623	0.2758	0.2049
2001	0.0620	0.1176	0.1458	0.1676	0.1864	0.2028	0.2294	0.2429	0.2658	0.2627	0.2740	0.1949
2002	0.0606	0.1057	0.1454	0.1662	0.1884	0.2048	0.2301	0.2526	0.2707	0.2794	0.2906	0.1937
2003	0.0778	0.0989	0.1416	0.1616	0.1844	0.2031	0.2244	0.2327	0.2534	0.2616	0.2814	0.1932
2004	0.0681	0.1108	0.1381	0.1511	0.1786	0.2038	0.2291	0.2383	0.2545	0.2615	0.2892	0.1974
2005	0.0785	0.1200	0.1449	0.1565	0.1734	0.2015	0.2205	0.2524	0.2539	0.2692	0.3084	0.1832
2006	0.0629	0.1103	0.1391	0.1537	0.1716	0.1980	0.2236	0.2499	0.2496	0.2917	0.2421	0.1753
2007	0.0596	0.1176	0.1437	0.1655	0.1754	0.1915	0.1935	0.2122	0.2563	0.2457	0.2161	0.1650
2008	0.0756	0.1286	0.1409	0.1631	0.1738	0.1899	0.2102	0.2399	0.2337	0.3018	0.2661	0.1658
2009	0.0330	0.1165	0.1398	0.1611	0.1671	0.1752	0.1864	0.2106	0.2531	0.2013	0.2105	0.1657
2010	-	0.1092	0.1334	0.1588	0.1661	0.1973	0.2125	0.2353	0.2384	0.2632	0.2771	0.1826
2011	0.0577	0.0831	0.1216	0.1294	0.1729	0.1754	0.1988	0.2169	0.2266	0.1999	0.2060	0.1723
2012	-	0.0832	0.1319	0.1482	0.1643	0.1677	0.1832	0.1901	0.1939	0.2272	0.2246	0.1668
2013	0.0620	0.0962	0.1341	0.1459	0.1661	0.1754	0.1888	0.1906	0.2043	0.2171	0.2451	0.1725

Table 17. Average number of standard gillnets used by fishers during the spring fishery (1 standard net = 15 fathoms) from telephone survey. Bold underlined values taken from dockside monitoring data where number of records are higher than the number from the telephone survey.

Year	Gaspe	Acadian Peninsula	Escuminac	West P.E.I.	Southeast New Brunswick	Magdalen Islands
1986	9	-	25	34	26	-
1987	17	-	21	-	30	-
1988	13	-	21	27	29	-
1989	20	-	22	29	28	-
1990	25	-	23	20	28	-
1991	20	-	24	27	28	-
1992	19	-	23	23	23	-
1993	16	-	23	23	23	-
1994	16	-	21	21	24	-
1995	7	-	22	18	21	-
1996	5	-	20	17	27	12
1997	15	-	19	17	25	10
1998	14	-	25	18	24	15
1999	16	19	24	21	28	14
2000	21	11	29	25	28	18
2001	20	20	27	24	28	18
2002	22	21	29	22	29	16
2003	19	9	29	26	29	20
2004	20	17	29	28	31	23
2005	20	**10**	28	**27**	29	24
2006	27	**14**	**27**	**23**	28	21
2007	23	24	**18**	**18**	**20**	**17**
2008	19	**9**	**23**	**19**	**23**	**12**
2009	16	15	* **23**	**17**	**22**	**14**
2010	20	**18**	* **23**	**17**	**22**	**14**
2011	18	**19**	**17**	**17**	**21**	12
2012	14	**15**	**16**	**18**	**18**	**12**
2013	**17**	**15**	**21**	**14**	**20**	**11**

*previous year value used because of lack of respondents

Table 18. Preliminary landings (t) (commercial = comm., and bait) by month and area in the 2012 and 2013 spring season gillnet fisheries.

		April		May		June		
Year	Area	comm.	bait	comm	bait	comm	bait	Total
2012	16A	6.2	0.0	0.6	0.0	8.4	0.0	15.3
	16B	180.5	0.0	7.2	0.0	119.0	0.0	306.8
	16C	2.4	0.0	3.1	0.0	0.0	0.0	5.5
	16D	0.8	0.6	0.2	0.5	0.0	0.6	2.7
	16E	22.5	0.0	9.0	0.0	15.1	0.0	46.6
	16F	0.0	0.0	0.0	0.0	18.6	0.0	18.6
	16G	0.0	0.0	0.0	0.0	20.8	0.0	20.8
	Total	212.5	0.6	20.0	0.5	181.9	0.6	416.2
2013	16A	1.6	0.0	1.6	0.0	3.1	0.0	6.3
	16B	304.2	0.0	32.7	0.0	39.8	0.0	376.7
	16C	14.4	0.0	4.7	0.0	0.0	0.0	19.1
	16D	2.1	1.2	0.0	0.0	0.0	0.0	3.3
	16E	407.7	0.0	27.6	0.0	14.9	0.0	450.2
	16F	0.0	0.0	0.0	0.0	20.0	0.0	20.0
	16G	0.0	0.0	0.0	0.0	22.8	0.0	22.8
	Total	730.0	1.2	66.6	0.0	100.6	0.0	898.4

*Table 19. Results from the multiplicative model (GLM) of spring spawners (April and May) gillnet CPUE for all areas. * Observations used are less because spring fishery is short and does not cover all weeks and areas.*

Class Level Information

Class	Levels	Values
Year	24	1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Week	13	9 11 12 13 14 15 16 17 18 19 20 21 22
Area	8	1 2 3 4 5 6 7 8

Number of Observations Read	4505
Number of Observations Used	2277*
Dependent Variable:	cpue
Weight	wt

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	39	7.55730699	0.19377710	45.48	<.0001
Error	2237	9.53218342	0.00426115		
Corrected Total	2276	17.08949042			

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Year	23	2.77493774	0.12064947	28.31	<.0001
Week	9	0.77990222	0.08665580	20.34	<.0001
Area	7	1.55038372	0.22148339	51.98	<.0001

R-Square (r^2)	Coeff. Var.	Root MSE	cpue Mean
0.442220	1.356120	0.065277	4.813546

Year	lsmean	CPUE kg / net-trip	Year	lsmean	CPUE kg / net-trip
1990	4.8	119.7	2002	4.6	95.9
1991	5.4	230.1	2003	4.8	123.8
1992	5.6	269.2	2004	4.5	86.6
1993	5.3	205.9	2005	4.3	72.5
1994	5.2	175.8	2006	4.4	78.4
1995	5.3	205.6	2007	4.4	78.5
1996	5.2	176.4	2008	4.5	86.9
1997	5.3	209.5	2009	4.6	103.0
1998	5.0	150.8	2010	3.8	43.8
1999	4.8	122.4	2011	4.1	58.3
2000	4.9	138.7	2012	4.0	55.9
2001	4.8	117.7	2013	4.8	117.1

Table 20. Spring spawner April - May gillnet catch rate at age (CPUE) for all fishing areas combined and acoustic survey index number at age used in the ADAPT-SPA population models.

	Age						
Year	4	5	6	7	8	9	10
CPUE GILLNET (number / net-trip)							
1990	141.9	79.0	41.8	48.6	75.5	35.1	14.1
1991	220.0	265.6	171.7	59.5	54.4	83.5	30.8
1992	641.3	246.4	161.8	73.9	34.0	41.7	30.4
1993	73.2	538.9	245.3	65.4	32.2	18.4	9.4
1994	54.2	228.2	449.7	83.8	33.3	11.3	4.1
1995	159.2	128.6	212.1	345.1	76.4	21.3	13.8
1996	17.7	506.0	96.0	148.9	99.0	32.6	6.2
1997	88.1	65.9	612.3	112.7	67.2	63.8	16.4
1998	86.5	176.3	25.3	333.6	38.2	27.3	22.0
1999	77.4	110.4	120.8	26.5	188.2	30.3	15.7
2000	108.6	144.9	138.3	68.7	40.4	105.9	26.4
2001	124.7	144.2	108.7	54.2	37.0	15.3	72.7
2002	76.7	199.7	83.0	39.3	22.6	12.5	11.4
2003	156.9	161.3	187.0	57.2	36.2	14.5	10.0
2004	29.0	167.9	60.0	94.5	35.8	12.9	4.6
2005	73.6	64.9	117.0	51.8	40.9	11.4	2.5
2006	59.8	214.2	76.0	24.3	13.1	17.8	1.3
2007	91.6	70.3	104.5	78.2	36.1	8.8	6.7
2008	158.8	175.8	64.3	71.2	15.2	3.0	1.3
2009	82.3	189.9	235.6	26.7	27.1	7.1	0.4
2010	53.1	37.6	64.4	33.5	16.6	17.3	0.1
2011	11.0	56.4	51.4	68.3	33.4	51.8	17.9
2012	45.2	30.8	52.1	76.6	36.9	27.1	25.3
2013	27.1	97.2	133.5	169.6	133.9	96.8	5.1
ACOUSTIC (number x 10^5)							
1994	1001	1096	1043	281	64	-	-
1995	769	214	249	206	50	-	-
1996	160	1600	405	265	300	-	-
1997	700	100	850	55	128	-	-
1998	318	197	56	379	64	-	-
1999	479	198	63	37	180	-	-
2000	246	68	54	16	48	-	-
2001	70	43	16	18	1	-	-
2002	23	88	35	8	17	-	-
2003	290	162	134	13	19	-	-
2004	13	13	6	0	0	-	-
2005	312	15	28	6	2	-	-
2006	208	185	18	9	0	-	-
2007	35	79	46	0	1	-	-
2008	67	63	25	9	15	-	-
2009	162	71	24	12	18	-	-
2010	392	81	83	39	24	-	-
2011	134	161	107	41	1	-	-
2012	274	93	67	31	19	-	-
2013	212	218	136	44	15	-	-

Table 21. Acoustic survey spring spawners numbers-at-age (x 1000; a) and biomass at age (t; b) for the same strata covered in Chaleurs-Miscou since 1994. Strata names are identified in Appendix 3b.

Year	0	1	2	3	4	5	6	7	8	9	10	11+	Total	4+
(a) Numbers (X 1000) at age														
1994	98865	3051	2548	231972	100087	109649	104274	28059	6389	7213	1020	3644	696770	360334
1995	2554	8959	46535	7724	76887	21389	24905	20645	4959	736	74	17	215383	149611
1996	68453	41784	278013	139355	16008	159956	40479	26474	29966	5851	3603	107	810048	282444
1997	0	2889	101589	68210	70032	9970	84978	5522	12833	14800	2648	2424	375894	203206
1998	30645	98770	151583	28563	31795	19716	5616	37904	6423	5438	3585	859	420898	111337
1999	28424	61163	238373	107078	47912	19836	6278	3667	18015	2748	1380	1564	536436	101400
2000	347612	27362	20037	29123	24640	6843	5361	1647	4821	2155	448	540	470589	46455
2001	768324	120686	27425	4997	6963	4343	1605	1844	119	500	440	455	937701	16269
2002	1074	217789	49751	12341	2289	8815	3494	847	1684	271	123	0	298478	17524
2003	0	83479	127660	24039	29016	16234	13418	1260	1878	346	1397	2052	300779	65600
2004	684	12340	229459	51870	1258	1328	556	0	0	0	0	0	297495	3143
2005	10	1473	15235	34207	31238	1542	2839	588	248	0	0	0	87380	36455
2006	20	28519	56533	15600	20794	18487	1770	885	0	257	0	0	142865	42193
2007	124	7037	22288	29720	3502	7938	4570	29	96	0	0	16	75320	16150
2008	0	16960	36332	11782	6672	6321	2459	941	1523	42	0	0	83033	17959
2009	0	133	36674	35845	16153	7076	2438	1224	1773	0	0	0	101316	28664
2010	0	1392	29137	37872	39180	8137	8291	3930	2351	1517	0	0	131807	63406
2011	0	0	14469	37487	13395	16097	10696	4107	106	3506	104	1249	101218	49262
2012	5913	0	4805	103902	27431	9291	6702	3095	1929	266	650	0	163983	49364
2013	0	0	594	8754	21203	21837	13612	4379	1456	0	0	0	71834	62486
(b) Biomass (t) at age														
1994	1038	136	244	36526	17115	21725	22366	6049	1887	1840	322	1065	110335	72369
1995	24	499	5296	1084	14131	4374	5540	4952	1347	228	25	6	37501	30603
1996	2127	2268	28877	20996	2935	34991	9021	6868	8364	1697	1290	44	119480	65209
1997	0	172	11950	9895	13283	2102	20383	1423	3620	4820	875	877	69405	47383
1998	460	5963	13981	3723	5368	4045	1272	9285	1656	1467	1059	267	48537	24419
1999	384	3085	23733	14666	8631	4058	1633	1008	5285	837	426	454	64183	22330
2000	2990	1539	2430	4533	4426	1466	1238	438	1388	610	124	176	21352	9865
2001	18567	6197	2823	747	1298	887	377	447	32	132	134	139	31760	3445
2002	16	12361	4436	1971	460	2063	844	221	506	78	37	0	22993	4207
2003	0	5268	12635	3731	5393	3597	3288	326	556	109	393	725	36011	14387
2004	14	653	21219	6680	164	271	129	0	0	0	0	0	29123	563
2005	0	89	1323	4441	4754	219	572	141	65	0	0	0	11601	5750
2006	0	1664	4651	2123	3547	2986	385	185	0	83	0	0	15626	7187
2007	1	453	1922	4001	589	1191	716	5	16	0	0	3	8895	2520
2008	0	988	3846	1558	1005	1105	419	187	268	9	0	0	9386	2993
2009	0	9	3673	4938	2236	1316	456	262	357	0	0	0	13244	4627
2010	0	75	2571	4293	5523	1378	1708	856	477	333	0	0	17212	10275
2011	0	0	1118	4144	1757	2491	1948	798	22	684	24	223	13208	7947
2012	38	0	449	11671	3413	1364	1130	544	379	49	140	0	19175	7019
2013	0	0	44	1068	2993	3534	2466	935	297	0	0	0	11339	10225

Table 22. Diagnostics of spring spawner ADAPT-VPA results using gillnet CPUE and acoustic survey age-disaggregated population number indices (parameters are in linear scale).

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION: Mean square residual = 0.6849

Parameter	Parameter estimate	Standard error	Relative error	Bias	Relative bias
Population estimates in 2014					
N[2011, 10]	3720	1230	0.331	182	0.049
N[2012, 10]	3360	1160	0.345	160	0.048
N[2013, 10]	1700	647	0.380	98	0.057
N[2014, 5]	26100	16000	0.613	4880	0.187
N[2014, 6]	31300	13800	0.442	3020	0.097
N[2014, 7]	12000	4660	0.387	8420	0.070
N[2014, 8]	13600	4670	0.344	735	0.054
N[2014, 9]	7180	2420	0.337	344	0.048
N[2014, 10]	5720	1940	0.340	265	0.046
Catchability - Gillnet CPUE disaggregated ages 4-10					
q CPUE age 4	0.0016	0.0003	0.174	0.000018	0.013
q CPUE age 5	0.0037	0.0060	0.172	0.000047	0.013
q CPUE age 6	0.0054	0.0009	0.172	0.000072	0.013
q CPUE age 7	0.0062	0.0011	0.172	0.000089	0.014
q CPUE age 8	0.0072	0.0012	0.172	0.000110	0.015
q CPUE age 9	0.0066	0.0015	0.173	0.000143	0.017
q CPUE age 10	0.0066	0.0011	0.174	0.000121	0.018
Catchability - Acoustic survey disaggregated ages 4-8					
q Acoust. age 4	0.0048	0.0009	0.192	0.000074	0.016
q Acoust. age 5	0.0045	0.0009	0.190	0.000071	0.016
q Acoust. age 6	0.0046	0.0009	0.190	0.000076	0.017
q Acoust. age 7	0.0037	0.0007	0.200	0.000073	0.020
q Acoust. age 8	0.0042	0.0008	0.201	0.000090	0.021

Table 23. Spring spawner population numbers (x 1000) at age from the ADAPT calibration using gillnet CPUE and acoustic survey age-disaggregated population number indices.

Year	2	3	4	5	6	7	8	9	10	11+	Total 4-11
1978	55654	40139	152941	30161	27429	11231	5825	6843	29134	8862	55654
1979	65559	32115	24154	80721	21005	16400	7437	3890	4760	25896	65559
1980	53284	40506	15631	13187	27370	13103	6453	4056	1609	11241	53284
1981	200244	33446	15479	5201	6980	4596	1708	880	812	8562	200244
1982	266060	163223	15793	5510	2512	3670	769	413	118	6355	266060
1983	253863	215521	108975	8809	3574	1669	2655	204	30	4645	253863
1984	319825	206487	157012	62241	4887	2500	1240	2110	87	3820	319825
1985	129929	261256	164355	113881	41569	3371	1993	939	1684	3194	129929
1986	86021	105319	205322	120913	78083	28825	2138	1542	740	3665	86021
1987	134674	66633	80189	146962	80985	47964	18335	1209	784	3029	134674
1988	162032	108920	51658	57443	92831	49521	24273	8058	159	2352	162032
1989	215478	126487	84067	35230	36163	52328	25789	10360	3584	69	215478
1990	537292	176034	97312	50298	23012	20990	27379	13449	4123	1633	537292
1991	252685	435102	136747	66443	33667	14503	13554	13663	6718	2837	252685
1992	171999	205233	342272	98636	39323	18222	8443	7599	6409	3672	171999
1993	589084	140044	163544	246520	67245	23151	11173	5078	3762	4111	589084
1994	68889	479500	112306	122909	160638	36179	13139	6112	1766	1641	68889
1995	132993	56355	387056	84640	75350	82679	19321	6329	3328	904	132993
1996	115355	107605	44525	289451	54370	41338	34919	8590	2669	1441	115355
1997	110137	94097	85068	34107	183557	33088	19292	18384	3927	1421	110137
1998	109483	89793	75674	61627	23138	109365	20015	10627	10220	2761	109483
1999	141664	89368	72089	53240	34915	16711	61141	12895	6198	7516	141664
2000	67142	114305	69049	48708	32383	17997	10813	33018	7352	8033	67142
2001	85242	53773	88716	42403	24236	12120	7654	4598	16136	8267	85242
2002	28686	65946	39850	58084	20742	10027	4504	2871	2346	12135	28686
2003	64430	22814	48902	25336	30446	9978	4487	1740	1283	9778	64430
2004	40496	52562	17832	29579	10561	13207	4418	1457	534	7707	40496
2005	42431	32696	40838	11864	10442	3716	3082	762	163	5464	42431
2006	57987	33102	25028	27843	6601	3112	735	732	68	4340	57987
2007	49080	47262	25642	18849	16973	3368	1949	325	249	3514	49080
2008	62212	36889	34665	17003	12419	9683	607	653	80	2747	62212
2009	38178	47735	28339	25158	10040	8613	6097	138	403	2242	38178
2010	69046	30838	37205	22041	18239	5345	6344	4662	32	1959	69046
2011	42726	56425	24715	28768	16993	13270	3276	4864	3535	1620	42726
2012	62984	34413	45435	19485	22194	12714	9444	2175	3204	3637	62984
2013	65280	51550	27682	36541	15533	17675	9844	7526	1606	5389	65280
2014	76774[1]	53280[2]	41711[3]	21256	28248	11194	12846	6841	5451	5645	76774

[1] SSB 2012 multiplied by mean (2005-2011) age 2 survival ratio (number / SSB)

[2] SSB 2011 multiplied by mean (2006-2012) age 3 survival ratio (number / SSB)

[3] SSB 2010 multiplied by mean (2007-2013) age 4 survival ratio (number / SSB)

Table 24. Spring spawner biomass (t) at age from the ADAPT calibration using gillnet CPUE and acoustic survey age-disaggregated population number indices.

Year	2	3	4	5	6	7	8	9	10	11+	Total 4-11
1978	6290	5700	32557	6983	7032	3251	1730	2275	10673	3181	67682
1979	7641	4847	4410	18981	5210	4713	2236	1266	1604	9441	47860
1980	6920	6872	2880	2969	7141	3414	1869	1216	568	3971	24029
1981	26806	5662	3073	1185	2071	1405	488	270	258	3353	12103
1982	16305	27437	3088	1371	724	1377	268	138	44	2496	9507
1983	18955	32211	21158	2001	928	535	819	78	11	1884	27415
1984	29959	33631	28656	13621	1298	741	441	634	34	1449	46874
1985	12194	39982	31663	25309	10443	1031	652	334	674	1201	71307
1986	9397	17201	43044	27851	20424	8604	717	486	256	1508	102890
1987	12654	11032	16200	34779	21813	14108	5948	401	245	1180	94675
1988	13581	17492	10261	13329	25199	14829	7949	2873	54	861	75354
1989	23025	18222	15905	7855	9674	16185	8378	3616	1330	25	62969
1990	66800	28868	19832	11935	6011	6237	8797	4488	1469	575	59345
1991	26786	73790	25908	14881	8570	4023	4156	4320	2231	1034	65123
1992	16791	29715	58914	19656	9140	4644	2343	2294	1989	1227	100207
1993	45984	18521	25948	44912	14147	5641	2929	1421	1138	1287	97423
1994	6924	61541	17643	21693	31380	7904	3286	1717	493	511	84626
1995	11817	8302	62367	14873	14598	17791	4617	1698	1004	272	117221
1996	10537	14290	7526	51308	10626	8705	8167	2114	758	426	89629
1997	10498	12525	14513	6466	35827	7004	4441	4626	975	429	74281
1998	9430	11867	11962	11124	4559	23543	4623	2645	2690	773	61920
1999	13439	11159	11011	9361	6959	3689	14121	3251	1613	2062	52068
2000	6093	15144	10590	8564	6452	3947	2649	8173	1926	2195	44495
2001	7635	7438	13982	7433	4716	2657	1799	1192	4177	2216	38172
2002	2322	8624	6203	10321	4053	2166	1084	736	639	3353	28555
2003	4988	2791	7495	4435	5955	2139	1038	440	341	2742	24587
2004	3760	6144	2608	5025	2047	2849	1022	355	137	2120	16162
2005	3836	4143	6004	1920	1981	788	741	187	43	1552	13216
2006	5397	4277	3734	4562	1223	661	173	184	19	1108	11663
2007	4222	5950	3891	3095	3077	659	425	82	62	882	12172
2008	5448	4749	5307	2884	2267	1943	131	145	22	702	13401
2009	3581	6401	4269	4154	1752	1620	1283	34	87	565	13764
2012	4144	3843	5544	3606	3312	1031	1328	1044	8	463	16337
2013	3064	6501	3247	4767	2900	2628	703	1123	772	377	16518
2012	4364	3601	6101	2841	3779	2279	1836	446	727	771	18780
2013	4857	5446	3839	5734	2636	3146	1840	1483	329	1272	20279
2014	5512	5781	5622	3319	4809	2072	2552	1444	1182	1281	22280

Table 25. Spring spawner fishing mortality at age for the ADAPT calibration using gillnet CPUE and acoustic survey age-disaggregated population number indices.

Year	2	3	4	5	6	7	8	9	10	11+	Mean 6-8
1978	0.35	0.308	0.439	0.162	0.314	0.212	0.204	0.163	0.183	0.183	0.243
1979	0.282	0.52	0.405	0.882	0.272	0.733	0.406	0.683	0.545	0.859	0.470
1980	0.266	0.762	0.9	0.436	1.584	1.837	1.793	1.409	1.601	0.104	1.738
1981	0.004	0.55	0.833	0.528	0.443	1.588	1.22	1.811	1.515	0.121	1.084
1982	0.011	0.204	0.384	0.233	0.209	0.124	1.129	2.406	1.767	0.117	0.487
1983	0.007	0.117	0.36	0.389	0.157	0.097	0.03	0.649	0.339	0	0.095
1984	0.002	0.028	0.121	0.204	0.171	0.026	0.079	0.025	0.052	0	0.092
1985	0.01	0.041	0.107	0.177	0.166	0.255	0.057	0.038	0.048	0.107	0.159
1986	0.055	0.073	0.134	0.201	0.287	0.252	0.37	0.477	0.423	0.131	0.303
1987	0.012	0.055	0.134	0.259	0.292	0.481	0.622	1.831	1.226	0.136	0.465
1988	0.048	0.059	0.183	0.263	0.373	0.452	0.651	0.61	0.631	100	0.492
1989	0.002	0.062	0.314	0.226	0.344	0.448	0.451	0.721	0.586	100	0.414
1990	0.011	0.053	0.182	0.201	0.262	0.237	0.495	0.494	0.495	0.541	0.331
1991	0.008	0.04	0.127	0.325	0.414	0.341	0.379	0.557	0.468	2.328	0.378
1992	0.006	0.027	0.128	0.183	0.33	0.289	0.308	0.503	0.406	1.589	0.309
1993	0.006	0.021	0.086	0.228	0.42	0.366	0.403	0.856	0.63	100	0.396
1994	0.001	0.014	0.083	0.289	0.464	0.427	0.53	0.408	0.469	100	0.474
1995	0.012	0.036	0.091	0.243	0.4	0.662	0.611	0.663	0.637	100	0.558
1996	0.004	0.035	0.067	0.255	0.297	0.562	0.442	0.583	0.512	2.361	0.434
1997	0.004	0.018	0.122	0.188	0.318	0.303	0.396	0.387	0.392	0.682	0.339
1998	0.003	0.02	0.152	0.368	0.125	0.382	0.24	0.339	0.289	0.592	0.249
1999	0.015	0.058	0.192	0.297	0.463	0.235	0.416	0.362	0.389	0.292	0.371
2000	0.022	0.053	0.288	0.498	0.783	0.655	0.655	0.516	0.586	0.291	0.698
2001	0.057	0.1	0.224	0.515	0.683	0.79	0.781	0.473	0.627	0.288	0.751
2002	0.029	0.099	0.253	0.446	0.532	0.604	0.751	0.605	0.678	0.121	0.629
2003	0.004	0.046	0.303	0.675	0.635	0.615	0.925	0.982	0.953	0.092	0.725
2004	0.014	0.052	0.207	0.841	0.845	1.255	1.558	1.988	1.773	0.158	1.219
2005	0.048	0.067	0.183	0.386	1.011	1.421	1.238	2.211	1.724	0.036	1.223
2006	0.005	0.055	0.084	0.295	0.473	0.268	0.615	0.877	0.746	0.019	0.452
2007	0.086	0.11	0.211	0.217	0.361	1.514	0.893	1.199	1.046	0.073	0.923
2008	0.065	0.064	0.121	0.327	0.166	0.262	1.284	0.282	0.783	0.017	0.571
2009	0.013	0.049	0.051	0.122	0.43	0.106	0.068	1.256	0.662	0.026	0.201
2010	0.002	0.021	0.057	0.06	0.118	0.29	0.066	0.077	0.071	0.005	0.158
2011	0.016	0.017	0.038	0.059	0.09	0.14	0.209	0.217	0.213	0.021	0.146
2012	0	0.018	0.018	0.027	0.028	0.056	0.027	0.103	0.053	0.026	0.037
2013	0.003	0.012	0.064	0.057	0.128	0.119	0.164	0.122	0.026	0.011	0.137

Table 26. Spring spawner input parameters for the 2014 catch projections from the ADAPT calibration using gillnet CPUE and acoustic survey age-disaggregated population number indices, ages 2 to 11+.

Age	Maturity	Natural mortality	Beginning of year weight (kg)	Mean weight kg)	Partial Recruitment	Population numbers (X 1000) January 2014
2	0	0.2	0.068	0.087	0.07	76774
3	0	0.2	0.096	0.129	0.24	53280
4	1	0.2	0.124	0.141	0.39	41711
5	1	0.2	0.156	0.168	1	21256
6	1	0.2	0.170	0.173	1	28248
7	1	0.2	0.185	0.190	1	11194
8	1	0.2	0.199	0.209	1	12846
9	1	0.2	0.211	0.223	1	6841
10	1	0.2	0.217	0.223	1	5451
11+	1	0.2	0.227	0.233	1	5645

Table 27. Spring spawner catch and population projections from the ADAPT calibration using gillnet CPUE and acoustic survey age-disaggregated population number indices for ages 2 to 11+.

Age	Catch numbers (X 1000) 2014	Catch biomass (t) 2014	Population numbers (X 1000) 2015	Population biomass (t) 2015
2	1,685	147	76,774	5,221
3	3,896	503	61,336	5,888
4	4,835	682	40,107	4,973
5	5,722	961	29,793	4,648
6	7,605	1,316	12,263	2,085
7	3,014	573	16,298	3,015
8	3,458	723	6,458	1,285
9	1,842	411	7,411	1,564
10	1,468	327	3,947	856
11+	1520	354	6,402	1,453
2 +	35,045	5,995	260,789	30,988
3 +	33,360	5,849	184,015	25,768
4 +	29,464	5,346	122,679	19,880

Table 28. Fall fishery samples and landings by zone used to derive 2012 and 2013 catch and weight-at-age matrices for 4T herring.

Gear/ Region	Fishery area and date	Zone	Samples	Landings (t)
2012 FIXED GEAR GILLNETS				
North	Gaspe /Chaleur (16AB) August 1 - 10	4Tmnopq	3	1,062.1
North	Gaspe/Chaleur (16AB) August 11 - 24	4Tmnopq	5	3,424.2
North	Gaspe/Chaleur (16AB) August 25 – Sept. 6	4Tmnopq	3	6,474.4
North	Gaspe/Chaleur (16AB) Sept. 7 +	4Tmnopq	4	3,986.3
Middle	Escuminac - West P.E.I. (16CE) July – August	4Tl	2	2,213.0
Middle	Escuminac - West P.E.I. (16CE) Sept. 1 - 10	4Tl	6	2,647.5
Middle	Escuminac - West P.E.I. (16CE) Sept. 11 +	4Tl	2	1,974.2
South	Iles de la Madeleine (16D) fall	4Tf	0*	0.1
South	East P.E.I. (16G) North Lake Sept. 1 - 15	4Tgj	2	955.4
South	East P.E.I. (16G) North Lake Sept. 16 +	4Tgj	1	907.2
South	East P.E.I. (16G) Fishermans Bank fall	4Tgj	3	1,399.2
South	Pictou (16F) July – Sept. 5	4Th	1	1,440.8
South	Pictou (16F) Sept. 6 - 15	4Th	2	1,911.1
South	Pictou (16F) Sept. 16 +	4Th	3	3,490.9
Fixed gear total		4T	37	31,886.4
2012 MOBILE GEAR PURSE SEINE				
North	East of Grande-Anse (16B) Sept. – Oct. 31	4Tmn	1	278.0
North	East of Grande-Anse (16B) Nov. - Dec.	4Tmn	2	365.0
Mobile gear total		4T	3	643.0
2012 Fall - all gears		4T	40	32,529.4
2013 FIXED GEAR - GILLNETS				
North	Gaspe / Chaleur (16AB) July – August 23	4Tmnopq	3	6,998.6
North	Gaspe / Chaleur (16AB) August 24 - 31	4Tmnopq	4	3,767.3
North	Gaspe / Chaleur (16AB) Sept. +	4Tmnopq	3	4,684.2
Middle	Escuminac – West P.E.I. (16CE) July – August	4Tl	4	2,342.3
Middle	Escuminac-WP.E.I. (16CE) Sept. 1 - 8	4Tl	5	2,241.9
Middle	Escuminac-WP.E.I. (16CE) Sept. 9 +	4Tl	3	1,428.6
South	Ile de la Madeleine (16D) fall	4Tf	2	35.7
South	East P.E.I. (16G)) July – Sept. 13	4Tgj	2	960.5
South	East P.E.I. (16G) Sept. 14 - 20	4Tgj	1	649.6
South	East P.E.I. (16G) Sept. 21 +	4Tgj	2	1,320.7
South	Pictou (16F) Sept. 8 - 20	4Th	3	4,635.8
South	Pictou (16F) Sept. 21 +	4Th	1	864.2
Fixed gear total		4T	33	29,929.4
2013 MOBILE GEAR PURSE SEINE				
North	East of Grande-Anse (16B) Sept. - Nov. 11	4Tmn	7	639.0
North	East of Grande-Anse (16B) Nov. 12 - Dec.	4Tmn	8	1,418.2
Mobile gear total		4T	15	2,057.3
2013 Fall - all gears		4T	48	31,986.7

* in 2012 used samples from all of 4Tgj

Table 29a. Fall spawner catch-at-age (number of fish, X 1000) for 4T herring from the fixed gear fishery, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1978	0	41	2241	5405	3831	885	949	4833	80	140	2341	20746
1979	910	16	579	11579	5711	2864	724	1036	915	322	632	25288
1980	0	64	7884	4374	6283	1105	2348	484	556	409	173	23679
1981	0	66	6095	24399	6935	2792	1231	1217	172	281	322	43510
1982	0	0	2108	14307	16990	5183	2815	1137	396	121	129	43186
1983	0	0	821	20721	10277	13817	2380	1808	573	63	263	50723
1984	0	0	891	24352	15093	8985	6422	1574	571	230	101	58218
1985	0	0	199	6555	29974	15570	8683	7684	2542	746	35	71989
1986	0	383	1535	31954	16807	36455	19831	9356	4014	580	980	121895
1987	0	16	8641	36322	29218	20947	36964	15570	10053	4562	2100	164393
1988	0	0	1346	21922	44378	21681	14350	15582	8043	2998	2618	132919
1989	0	0	332	14260	23308	30767	15186	6947	8752	3449	2557	105557
1990	0	14	3446	22450	20679	28712	59355	18217	10181	10648	6677	180380
1991	0	0	160	39661	10594	8060	10947	13617	5100	2963	5036	96137
1992	0	0	23	11368	54218	13042	7389	8589	9518	4219	6988	115355
1993	0	0	82	2703	30919	36647	5829	2921	2977	1513	2551	86142
1994	0	0	0	8866	12217	48466	70721	12083	9869	8923	14875	186021
1995	0	0	24	3853	41867	17237	51184	49433	9090	6467	15099	194254
1996	0	0	4	19658	19632	46515	10509	23236	23961	4955	10878	159349
1997	0	0	1106	17513	64208	13459	21133	3890	6859	6469	3968	138605
1998	0	0	59	23256	32702	47339	11459	17637	3134	5994	8757	150336
1999	0	0	265	38385	68890	39101	23455	5285	7283	1792	3441	187895
2000	0	0	356	36338	108837	41591	11871	8524	1797	2010	1105	212429
2001	0	0	954	30198	64970	60448	21007	4671	2361	608	1345	186562
2002	0	1	487	48068	38902	40482	29832	7787	1927	1543	951	169979
2003	0	0	419	22302	78098	28410	28940	26198	5985	1884	1485	193722
2004	0	0	16	34187	39004	40265	15157	13024	7602	2158	921	152334
2005	0	0	3	7813	83076	54562	44002	13856	11128	4652	635	219729
2006	0	0	55	10615	53320	70794	31427	19658	9990	5392	1885	203137
2007	0	0	716	6563	27935	57737	58441	24205	7408	4559	1953	189518
2008	0	0	2121	35457	16066	29793	32568	38194	10187	5695	4015	174097
2009	0	0	1044	33189	73772	24332	38549	16509	6561	6072	3108	203137
2010	0	0	10	6906	47345	72522	21305	20021	13469	6671	3284	191532
2011	0	0	2	2412	16124	46530	65206	13769	9393	7293	5578	166307
2012	0	0	16	322	11915	37337	53254	34697	5706	3911	3043	150201
2013	0	0	25	1949	11205	45044	50959	23679	8499	485	233	142078

Table 29b. Fall spawner mean weight-at-age (kg) for 4T herring from the fixed gear fishery, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Mean
1978	-	0.0766	0.1408	0.2420	0.2780	0.3125	0.3112	0.3707	0.3928	0.3613	0.4283	0.2959
1979	0.0230	0.1319	0.1936	0.2432	0.2819	0.3118	0.3544	0.3938	0.4175	0.4327	0.4233	0.2731
1980	-	0.2116	0.2072	0.2439	0.3170	0.3496	0.3106	0.3577	0.4542	0.4173	0.4391	0.2742
1981	-	0.1743	0.2200	0.2584	0.3104	0.3588	0.3927	0.4063	0.4585	0.4693	0.4520	0.2791
1982	-	-	0.2240	0.2671	0.3025	0.3351	0.3754	0.3808	0.3961	0.3844	0.4471	0.2992
1983	-	-	0.1913	0.2419	0.2809	0.3161	0.3471	0.3744	0.3720	0.4248	0.4340	0.2815
1984	-	-	0.2229	0.2448	0.2825	0.3178	0.3478	0.3988	0.4142	0.4028	0.5062	0.2837
1985	-	-	0.2119	0.2404	0.2892	0.3303	0.3626	0.3842	0.4120	0.4376	0.4659	0.3184
1986	-	0.1747	0.2000	0.2461	0.2897	0.3221	0.3685	0.3898	0.4039	0.4427	0.4350	0.3126
1987	-	0.1738	0.2363	0.2480	0.2814	0.3128	0.3441	0.3710	0.3895	0.3916	0.4316	0.3098
1988	-	-	0.2294	0.2605	0.2870	0.3210	0.3460	0.3765	0.4016	0.3976	0.4276	0.3166
1989	-	-	0.2180	0.2539	0.2912	0.3226	0.3458	0.3735	0.3902	0.4142	0.4284	0.3239
1990	-	0.1480	0.1961	0.2445	0.2832	0.3245	0.3479	0.3697	0.3919	0.4087	0.4323	0.3324
1991	-	-	0.1933	0.2308	0.2627	0.2931	0.3334	0.3512	0.3653	0.3771	0.4055	0.2890
1992	-	-	0.1993	0.2238	0.2543	0.2817	0.3082	0.3429	0.3511	0.3645	0.4055	0.2856
1993	-	-	0.1718	0.2196	0.2403	0.2640	0.2803	0.3271	0.3477	0.3474	0.3899	0.2653
1994	-	-	-	0.2101	0.2372	0.2594	0.2877	0.3159	0.3432	0.3590	0.3873	0.2895
1995	-	0.1033	0.1844	0.2070	0.2309	0.2504	0.2798	0.2980	0.3347	0.3587	0.3843	0.2831
1996	-	-	0.1720	0.2210	0.2448	0.2573	0.2818	0.3068	0.3241	0.3625	0.3953	0.2829
1997	-	-	0.1761	0.2055	0.2345	0.2596	0.2728	0.3100	0.3285	0.3406	0.3976	0.2551
1998	-	-	0.1592	0.2121	0.2331	0.2588	0.2848	0.2919	0.3251	0.3388	0.3721	0.2630
1999	-	-	0.1642	0.2107	0.2366	0.2494	0.2746	0.2993	0.3006	0.3508	0.3549	0.2461
2000	-	-	0.1689	0.2114	0.2325	0.2582	0.2762	0.3017	0.3206	0.3272	0.3664	0.2414
2001	-	-	0.1697	0.2097	0.2337	0.2526	0.2734	0.2972	0.3114	0.3392	0.3146	0.2436
2002	-	0.0314	0.1865	0.2184	0.2393	0.2562	0.2783	0.2912	0.3150	0.3173	0.3356	0.2486
2003	-	-	0.1632	0.2075	0.2314	0.2543	0.2686	0.2905	0.3095	0.3312	0.3488	0.2497
2004	-	-	0.1462	0.2023	0.2225	0.2420	0.2616	0.2840	0.3013	0.3118	0.3375	0.2381
2005	-	-	0.1880	0.1970	0.2244	0.2377	0.2495	0.2727	0.2840	0.2948	0.3212	0.2396
2006	-	-	0.1676	0.1981	0.2200	0.2392	0.2520	0.2620	0.2868	0.2928	0.3115	0.2407
2007	-	-	0.1490	0.1960	0.2036	0.2239	0.2389	0.2464	0.2603	0.2685	0.2905	0.2304
2008	-	0.0927	0.1300	0.1786	0.2120	0.2236	0.2366	0.2467	0.2515	0.2649	0.2837	0.2241
2009	-	-	0.1510	0.1874	0.2015	0.2308	0.2460	0.2603	0.2695	0.2688	0.2694	0.2209
2010	-	-	0.1322	0.1719	0.2043	0.2143	0.2366	0.2530	0.2616	0.2792	0.2905	0.2237
2011	-	-	0.1062	0.1770	0.1871	0.2134	0.2211	0.2469	0.2606	0.2631	0.2745	0.2230
2012	-	-	0.1205	0.1559	0.1834	0.1991	0.2140	0.2212	0.2437	0.2567	0.2739	0.2129
2013	-	-	0.1334	0.1622	0.1933	0.2021	0.2121	0.2269	0.2320	0.2650	0.2726	0.2107

Table 30a. Fall spawner catch-at-age (number of fish, X 1000) for 4T herring from the mobile gear fishery, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1978	0	1351	21407	23331	21495	4337	5052	15023	1844	1268	17790	112898
1979	156	5951	8965	7073	4946	7233	2077	3241	3851	1660	11889	57042
1980	151	2944	41338	15803	21870	10293	4861	1793	2584	1745	1850	105231
1981	18	1118	10011	11787	1076	297	447	31	187	0	0	24972
1982	0	1018	8889	3585	6962	841	135	156	104	26	263	21978
1983	0	222	5708	6865	2643	4141	720	167	224	30	91	20811
1984	0	398	1075	4824	4988	2748	1795	386	88	11	39	16353
1985	0	331	1904	2489	7414	6556	2955	2205	1837	574	0	26263
1986	0	347	2524	2619	3115	5966	3526	1565	1614	208	218	21701
1987	0	1633	3373	2290	1037	1337	3663	3895	871	870	373	19342
1988	98	3951	2499	2766	3249	1559	3239	2822	1074	1402	1629	24288
1989	0	828	1073	2202	4390	4541	1899	2252	2706	1557	1182	22630
1990	0	71	4463	3357	3653	2019	1981	1549	2084	988	296	20461
1991	0	0	5138	18139	4009	1188	1942	1452	382	712	2282	35246
1992	0	44	662	5408	13353	3001	2043	1442	1695	1330	4868	33846
1993	0	311	4383	2693	4587	7513	2282	1874	1767	2377	3285	31072
1994	0	15	287	8493	3669	10253	13275	1696	1803	1365	2728	43584
1995	0	22	2365	3798	20405	6426	9793	10346	2030	943	2486	58614
1996	0	389	2713	13239	5743	10708	4085	3218	2094	830	1082	44103
1997	0	429	4878	6312	9862	2434	4615	899	1380	788	916	32512
1998	0	51	1553	3198	3528	3734	737	2408	340	1088	1268	17905
1999	0	713	8064	12841	9250	4870	5969	2899	2228	643	1345	48821
2000	0	1029	6801	12522	12091	3670	1740	1041	306	320	254	39774
2001	146	2026	12826	7415	9713	8790	2662	1827	1064	250	330	47050
2002	0	1030	4482	14029	11196	9305	7609	1910	552	802	394	51310
2003	0	201	8565	15653	11982	7392	7828	7594	2503	852	675	63246
2004	0	519	4592	15304	6675	4522	2932	2145	1778	506	333	39306
2005	0	951	4454	17831	14885	4932	1227	683	673	270	154	46062
2006	0	1042	2355	3670	8741	5832	1575	519	330	242	54	24359
2007	0	1491	15237	5020	2838	3437	1735	511	108	46	23	30447
2008	0	1385	8080	5566	1678	834	607	771	3	24	0	18948
2009	0	179	4648	5917	2313	295	211	51	5	0	0	13618
2010	11	6	1875	7040	10603	7199	1296	705	208	90	1	29033
2011	0	1177	749	2101	2304	2477	1015	368	8	59	6	10263
2012	0	42	384	379	1129	1061	564	342	56	14	7	3979
2013	18	527	361	4290	4171	5766	6094	2586	1933	202	111	26060

Table 30b. Fall spawner mean weight-at-age (kg) for 4T herring from the mobile gear fishery, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Mean
1978	-	0.1001	0.1487	0.2142	0.2527	0.2780	0.2931	0.3312	0.3323	0.3156	0.3883	0.2598
1979	0.0673	0.1233	0.1795	0.2321	0.2658	0.2928	0.2908	0.3403	0.3647	0.3547	0.3799	0.2743
1980	0.0326	0.1082	0.1389	0.1744	0.2244	0.2453	0.2897	0.3385	0.3786	0.3880	0.4228	0.1967
1981	0.0798	0.1110	0.1814	0.2261	0.2558	0.3136	0.3656	0.2342	0.2614	0.4702	-	0.2080
1982	-	0.0948	0.1681	0.2206	0.2589	0.2786	0.3744	0.3341	0.3553	0.4551	0.4343	0.2131
1983	-	0.1028	0.1701	0.2134	0.2456	0.2831	0.3160	0.3754	0.3485	0.2223	0.4557	0.2257
1984	-	0.0955	0.1461	0.2084	0.2484	0.2786	0.3048	0.3292	0.3728	0.3916	0.4327	0.2405
1985	-	0.0897	0.1898	0.2150	0.2578	0.2805	0.3107	0.3265	0.3817	0.4187	-	0.2762
1986	-	0.1156	0.1584	0.2068	0.2516	0.2763	0.3064	0.3281	0.3350	0.3624	0.4038	0.2632
1987	-	0.1113	0.1724	0.2181	0.2496	0.2842	0.3185	0.3414	0.3510	0.3908	0.3927	0.2683
1988	0.0737	0.0949	0.1571	0.2204	0.2610	0.3072	0.3273	0.3406	0.3415	0.4143	0.3823	0.2595
1989	-	0.0988	0.1594	0.2126	0.2496	0.2789	0.3187	0.3229	0.3269	0.3597	0.3771	0.2787
1990	-	0.1051	0.1709	0.2125	0.2362	0.2885	0.3095	0.3231	0.3286	0.3379	0.3860	0.2529
1991	-	-	0.1492	0.1912	0.2215	0.2628	0.2788	0.3067	0.3097	0.3272	0.3798	0.2168
1992	-	0.0715	0.1276	0.1707	0.2107	0.2373	0.2610	0.2816	0.2902	0.3015	0.3353	0.2364
1993	-	0.0759	0.1277	0.1557	0.1988	0.2249	0.2583	0.2793	0.3101	0.3228	0.3539	0.2315
1994	-	0.0864	0.1341	0.1585	0.1737	0.2038	0.2223	0.2624	0.2742	0.3025	0.3358	0.2142
1995	-	0.0723	0.1179	0.1635	0.1772	0.1978	0.2241	0.2388	0.2710	0.3104	0.3406	0.2072
1996	-	0.0894	0.1327	0.1650	0.1831	0.2095	0.2222	0.2478	0.2689	0.2908	0.3313	0.1983
1997	-	0.0816	0.1413	0.1651	0.1911	0.2239	0.2261	0.2413	0.2619	0.2964	0.3391	0.1957
1998	-	0.0757	0.1259	0.1647	0.1874	0.2241	0.2478	0.2435	0.3033	0.3000	0.3874	0.2186
1999	-	0.0715	0.1278	0.1552	0.1892	0.2141	0.2485	0.2714	0.2892	0.3169	0.3556	0.1939
2000	-	0.0767	0.1306	0.1616	0.1847	0.2081	0.2311	0.2615	0.2626	0.2747	0.3182	0.1738
2001	0.0233	0.0785	0.1269	0.1562	0.1836	0.1998	0.2146	0.2403	0.2510	0.2375	0.2946	0.1684
2002	-	0.0839	0.1481	0.1880	0.2223	0.2448	0.2719	0.2897	0.3209	0.3288	0.3604	0.2214
2003	-	0.0810	0.1377	0.1687	0.1972	0.2188	0.2402	0.2597	0.2765	0.3178	0.3104	0.2030
2004	-	0.0801	0.1309	0.1603	0.1808	0.2042	0.2236	0.2477	0.2647	0.2784	0.2903	0.1812
2005	-	0.0783	0.1248	0.1515	0.1768	0.2018	0.2279	0.2823	0.2843	0.3012	0.3491	0.1684
2006	-	0.0789	0.1323	0.1638	0.1805	0.2059	0.2155	0.2284	0.2641	0.3014	0.3446	0.1810
2007	-	0.0859	0.1267	0.1519	0.1654	0.1845	0.2023	0.2153	0.2262	0.2585	0.2045	0.1454
2008	-	0.0930	0.1330	0.1526	0.1592	0.1788	0.1836	0.1966	0.2101	0.2178	-	0.1445
2009	-	0.0920	0.1227	0.1457	0.1658	0.1790	0.1952	0.2199	0.2306	-	-	0.1423
2010	0.0443	0.0939	0.1183	0.1369	0.1549	0.1658	0.1761	0.1984	0.1942	0.2054	0.3093	0.1533
2011	-	0.0694	0.1042	0.1230	0.1409	0.1532	0.1678	0.1793	0.2000	0.1860	0.2342	0.1337
2012	-	0.0761	0.1069	0.1273	0.1419	0.1619	0.1626	0.2064	0.2284	0.2189	0.2447	0.1519
2013	0.0329	0.0779	0.1134	0.1311	0.1525	0.1698	0.1855	0.2095	0.2199	0.2354	0.2526	0.1701

Table 31a. Fall spawner catch-at-age (number of fish, X 1000) for 4T herring from all gears combined, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1978	0	1392	23648	28735	25326	5221	6001	19857	1924	1408	20131	133643
1979	1067	5967	9544	18651	10658	10097	2801	4277	4765	1981	12522	82330
1980	151	3008	49222	20176	28154	11398	7208	2276	3140	2154	2022	128910
1981	18	1184	16105	36186	8011	3088	1678	1249	359	281	322	68481
1982	0	1018	10996	17892	23952	6024	2950	1293	500	147	392	65163
1983	0	222	6529	27586	12919	17958	3100	1975	797	93	355	71534
1984	0	398	1966	29176	20081	11733	8217	1960	659	241	140	74571
1985	0	331	2103	9044	37388	22126	11638	9888	4378	1320	35	98252
1986	0	730	4059	34573	19922	42420	23357	10921	5628	788	1198	143597
1987	0	1649	12014	38613	30255	22285	40626	19465	10923	5432	2474	183735
1988	96	3951	3845	24688	47627	23240	17589	18404	9117	4400	4248	157206
1989	0	828	1405	16462	27698	35308	17085	9199	11458	5006	3739	128187
1990	0	85	7909	25808	24332	30730	61336	19765	12265	11636	6973	200841
1991	0	0	5298	57800	14603	9249	12889	15069	5482	3675	7319	131384
1992	0	44	685	16777	67571	16043	9432	10031	11213	5550	11855	149201
1993	0	311	4465	5396	35507	44160	8111	4794	4743	3891	5836	117214
1994	0	15	287	17359	15886	58718	83996	13779	11672	10288	17604	229605
1995	0	22	2390	7651	62272	23663	60977	59780	11119	7409	17585	252868
1996	0	389	2717	32897	25375	57224	14594	26455	26055	5786	11960	203452
1997	0	429	5983	23825	74070	15893	25748	4789	8239	7257	4884	171117
1998	0	51	1612	26453	36230	51073	12196	20045	3473	7082	10026	168241
1999	0	713	8328	51226	78140	43971	29424	8184	9512	2435	4785	236717
2000	0	1029	7157	48860	120928	45260	13611	9565	2104	2330	1359	252203
2001	146	2026	13781	37614	74684	69238	23668	6497	3425	858	1675	233613
2002	0	1031	4969	62098	50098	49787	37441	9697	2479	2345	1345	221289
2003	0	201	8985	37955	90080	35802	36768	33792	8489	2736	2161	256968
2004	0	519	4608	49490	45679	44787	18089	15169	9380	2664	1254	191640
2005	0	951	4458	25645	97961	59495	45229	14540	11802	4923	789	265790
2006	0	1042	2410	14286	62061	76625	33002	20176	10320	5634	1939	227495
2007	0	1491	15953	11584	30774	61173	60176	24716	7516	4606	1977	219964
2008	0	1385	10202	41023	17744	30627	33175	38965	10190	5719	4015	193046
2009	0	179	5692	39106	76085	24627	38760	16560	6566	6072	3108	216755
2010	11	6	1886	13946	57948	79721	22601	20726	13677	6761	3284	220566
2011	0	1177	751	4513	18428	49007	66221	14137	9400	7352	5584	176570
2012	0	42	399	702	13045	38398	53818	35039	5762	3925	3050	154180
2013	18	527	386	6240	15377	50810	57053	26265	10432	687	344	168138

Table 31b. Fall spawner mean weight-at-age (kg) for 4T herring from all gears combined, 1978 to 2013.

Year	1	2	3	4	5	6	7	8	9	10	11+	Mean
1978	-	0.0994	0.1480	0.2194	0.2565	0.2838	0.2960	0.3408	0.3348	0.3201	0.3929	0.2654
1979	0.0295	0.1233	0.1804	0.2390	0.2744	0.2982	0.3072	0.3533	0.3748	0.3674	0.3821	0.2739
1980	0.0326	0.1104	0.1498	0.1895	0.2451	0.2554	0.2965	0.3425	0.3920	0.3935	0.4242	0.2110
1981	0.0798	0.1145	0.1960	0.2479	0.3030	0.3544	0.3855	0.4020	0.3560	0.4693	0.4520	0.2532
1982	-	0.0948	0.1788	0.2578	0.2898	0.3272	0.3753	0.3752	0.3877	0.3967	0.4385	0.2702
1983	-	0.1028	0.1728	0.2348	0.2737	0.3085	0.3399	0.3745	0.3654	0.3602	0.4396	0.2653
1984	-	0.0955	0.1809	0.2388	0.2740	0.3086	0.3384	0.3850	0.4086	0.4023	0.4856	0.2743
1985	-	0.0897	0.1919	0.2334	0.2829	0.3155	0.3494	0.3713	0.3993	0.4294	0.4659	0.3071
1986	-	0.1466	0.1741	0.2431	0.2837	0.3156	0.3592	0.3810	0.3841	0.4215	0.4293	0.3051
1987	-	0.1119	0.2183	0.2462	0.2803	0.3111	0.3418	0.3650	0.3865	0.3915	0.4257	0.3054
1988	0.0737	0.0949	0.1824	0.2560	0.2852	0.3200	0.3425	0.3710	0.3945	0.4029	0.4102	0.3078
1989	-	0.0988	0.1732	0.2484	0.2846	0.3170	0.3428	0.3611	0.3752	0.3972	0.4122	0.3159
1990	-	0.1123	0.1819	0.2403	0.2761	0.3221	0.3467	0.3661	0.3811	0.4027	0.4304	0.3243
1991	-	-	0.1505	0.2184	0.2514	0.2892	0.3252	0.3469	0.3614	0.3675	0.3975	0.2696
1992	-	0.0715	0.1300	0.2067	0.2457	0.2734	0.2980	0.3341	0.3419	0.3494	0.3767	0.2745
1993	-	0.0759	0.1285	0.1877	0.2350	0.2573	0.2741	0.3084	0.3337	0.3323	0.3696	0.2564
1994	-	0.0864	0.1341	0.1848	0.2225	0.2497	0.2774	0.3094	0.3326	0.3515	0.3794	0.2752
1995	-	0.0724	0.1185	0.1854	0.2133	0.2361	0.2708	0.2877	0.3231	0.3525	0.3782	0.2655
1996	-	0.0894	0.1328	0.1985	0.2308	0.2484	0.2651	0.2996	0.3196	0.3522	0.3895	0.2645
1997	-	0.0816	0.1477	0.1948	0.2288	0.2541	0.2644	0.2971	0.3174	0.3358	0.3866	0.2438
1998	-	0.0757	0.1271	0.2064	0.2287	0.2563	0.2826	0.2861	0.3230	0.3328	0.3741	0.2583
1999	-	0.0715	0.1290	0.1968	0.2310	0.2455	0.2693	0.2894	0.2979	0.3418	0.3551	0.2353
2000	-	0.0767	0.1325	0.1986	0.2277	0.2541	0.2705	0.2974	0.3122	0.3200	0.3574	0.2307
2001	0.0233	0.0785	0.1299	0.1991	0.2272	0.2459	0.2668	0.2812	0.2927	0.3095	0.3106	0.2284
2002	-	0.0838	0.1518	0.2115	0.2355	0.2541	0.2770	0.2909	0.3163	0.3212	0.3429	0.2423
2003	-	0.0810	0.1389	0.1915	0.2269	0.2470	0.2625	0.2836	0.2997	0.3270	0.3368	0.2382
2004	-	0.0801	0.1309	0.1893	0.2164	0.2382	0.2555	0.2788	0.2944	0.3054	0.3250	0.2265
2005	-	0.0783	0.1249	0.1653	0.2172	0.2347	0.2489	0.2731	0.2840	0.2952	0.3267	0.2272
2006	-	0.0789	0.1331	0.1893	0.2145	0.2367	0.2503	0.2611	0.2861	0.2932	0.3124	0.2343
2007	-	0.0859	0.1277	0.1769	0.2001	0.2217	0.2378	0.2458	0.2598	0.2684	0.2895	0.2186
2008	-	0.0930	0.1324	0.1750	0.2070	0.2224	0.2357	0.2457	0.2514	0.2647	0.2837	0.2163
2009	-	0.0920	0.1279	0.1811	0.2004	0.2301	0.2457	0.2602	0.2694	0.2688	0.2694	0.2160
2010	0.0443	0.0939	0.1183	0.1542	0.1952	0.2100	0.2331	0.2512	0.2606	0.2782	0.2905	0.2144
2011	-	0.0694	0.1042	0.1519	0.1813	0.2104	0.2203	0.2452	0.2606	0.2625	0.2745	0.2178
2012	-	0.0761	0.1075	0.1404	0.1798	0.1981	0.2135	0.2210	0.2435	0.2565	0.2738	0.2113
2013	0.0329	0.0779	0.1147	0.1408	0.1822	0.1985	0.2092	0.2251	0.2298	0.2563	0.2662	0.2044

Table 32. Acoustic survey fall spawners numbers-at-age (x 1000; a) and biomass at age (t; b) for the same strata covered in Chaleurs-Miscou since 1994. Strata names are identified in Appendix 3b.

Year	1	2	3	4	5	6	7	8	9	10	11+	Total	4+
(a) Numbers (X 1000) at age													
1994	1672	2157	4442	201387	61956	33090	17255	2309	0	12	1918	326198	317926
1995	386	12349	22326	11645	50030	9306	15773	23592	1762	767	868	148803	113743
1996	50815	225769	241001	163904	21951	72902	16442	9671	4046	961	1405	808868	291283
1997	0	66808	306768	200366	69384	8383	32111	9572	8225	3820	1304	706741	333165
1998	2013	66600	190598	74419	45341	27959	5228	22791	3178	5052	4298	447477	188266
1999	3843	59703	308283	191388	63421	32461	15972	2502	4774	4719	819	687887	316057
2000	79504	55502	127954	188246	137871	40048	13236	6624	2368	3731	2288	657371	394412
2001	83592	96857	32803	12930	10047	8640	1367	817	214	125	76	247468	34216
2002	1227	166012	32158	31345	20360	27785	16128	4708	689	93	144	300647	101251
2003	611	50128	255384	67523	19953	5758	6693	7959	1644	699	0	416354	110230
2004	0	29536	69627	53080	10888	2238	63	278	0	734	0	166443	67280
2005	21	29089	62771	253848	138439	31786	10934	4140	4135	1762	1939	538863	446983
2006	0	220736	75112	43095	75211	50965	7324	1405	802	543	0	475193	179345
2007	0	78619	147272	42055	19589	11057	7524	139	712	571	0	307537	81647
2008	8	71725	90952	50361	7565	4737	5166	3304	517	229	0	234565	71879
2009	0	71658	112022	80911	39829	5644	1569	833	134	37	0	312637	128957
2010	0	34571	107009	113652	94280	25025	4023	1292	213	213	0	380279	238699
2011	0	28930	41688	86376	67768	51302	22479	4808	2908	1073	0	307331	236713
2012	0	371	265405	110061	101562	53883	19331	1474	2789	283	0	556032	289383
2013	0	3968	18797	170061	69733	97874	40830	10829	7674	11321	0	431087	408322
(b) Biomass (t) at age													
1994	34	157	540	30231	9957	6582	3603	551	0	3	608	52264	51535
1995	19	803	2569	1882	9009	1711	3538	5654	484	229	275	26175	22782
1996	1859	17599	29408	24826	3959	14575	3534	2329	1127	270	406	99894	51025
1997	0	4688	41513	31449	12682	1768	6959	1970	2066	1036	337	104469	58265
1998	37	4838	21929	11505	7972	5845	1245	5292	814	1399	1360	62235	35434
1999	78	4097	37552	28717	11786	6624	3750	652	1244	1000	239	95739	54012
2000	1367	4137	17712	31877	27887	9135	3362	1835	662	1085	851	99908	76695
2001	2261	6773	3923	2006	1766	1710	293	189	53	38	23	19039	6078
2002	22	11855	4006	4771	3852	5493	3737	1140	186	24	42	35131	19245
2003	40	3736	30926	10589	3503	1213	1562	1970	445	201	0	54177	19483
2004	0	2315	8477	7771	1687	434	14	62	0	174	0	20936	10142
2005	1	2218	7765	37164	23685	6207	2207	1141	1167	544	572	82670	72686
2006	0	17329	9113	6446	13042	9689	1466	310	195	140	0	57739	31289
2007	0	6436	18111	5929	3043	1995	1467	33	163	118	0	37307	12748
2008	0	6040	11960	7370	1230	822	943	590	106	45	0	29106	11106
2009	0	6343	13197	11539	6260	940	296	159	19	8	0	38756	19222
2010	0	2484	11442	14899	14389	4085	765	221	49	49	0	48381	34457
2011	0	2009	3940	10537	9474	8078	3785	914	606	206	0	39549	33601
2012	0	25	26754	13066	13584	8166	3301	258	369	48	0	65570	38791
2013	0	301	2065	21828	10080	15566	7291	2003	1515	2355	0	62999	60638

Table 33. Average number of standard nets used during the fall inshore fishery (1 standard net = 15 fathoms) from telephone survey and dockside monitoring program (DMP) data. Bold underlined values taken from DMP where the number of records id higher than the telephone survey.

Year	Acadian Peninsula	Escuminac	Nova Scotia	East P.E.I.	West P.E.I.
1986	5	9	7	9	8
1987	5	9	7	7	7
1988	5	6	6	7	7
1989	5	9	6	6	6
1990	5	11	6	7	7
1991	5	7	6	7	7
1992	5	9	5	5	11
1993	6	7	4	5	7
1994	5	8	5	7	10
1995	5	8	6	7	7
1996	5	8	6	6	6
1997	5	8	5	7	7
1998	5	7	6	8	7
1999	6	8	6	8	9
2000	5	9	6	8	8
2001	5	9	7	8	9
2002	6	9	7	8	9
2003	5	8	6	8	8
2004	6	8	7	10	10
2005	6	8	6	8	8
2006	6	8	5	8	**12**
2007	6	**10**	4	8	7
2008	6	**10**	**6**	**8**	**7**
2009	6	**10**	**5**	**7**	**7**
2010	6	**10**	6	**9**	**9**
2011	7	**10**	6	**9**	**9**
2012	7	**8**	**7**	**8**	**8**
2013	7	**8**	6	**9**	**8**

Table 34. Percentage of nets that are 2⅝” mesh in the fall gillnet fishery weighted by landings per area.

Year	%	Year	%
1986	75	2000	70
1987	92	2001	72
1988	91	2002	79
1989	89	2003	81
1990	81	2004	82
1991	79	2005	87
1992	68	2006	91
1993	63	2007	88
1994	61	2008	96
1995	54	2009	97
1996	56	2010	94
1997	58	2011	95
1998	60	2012	97
1999	64	2013	99

Table 35. Average number of standard (15 fathom) gillnets (nets) and number of net-hauls (Net-hauls) used in the main fishing areas of the fall inshore fishery based on information provided from the telephone survey.

	Gaspe		Chaleurs		Escuminac		West PEI		Nova Scotia		East PEI	
Year	Nets	Net-hauls	Nets	Net-hauls	Nets	Net-hauls	Nets	Net-hauls	Nets	Net-hauls	Nets	Net-hauls
1986	5.6	6.8	5.2	7.7	9.4	9.4	7.8	7.8	6.8	9.6	8.7	9.0
1987	3.7	8.6	4.8	13.2	8.6	10.0	6.8	8.6	6.6	10.0	6.8	8.5
1988	5.0	9.9	4.8	12.1	6.4	18.9	7.3	13.6	6.4	10.2	6.6	9.7
1989	5.9	11.3	5.1	12.8	8.6	29.2	5.9	8.5	5.6	6.4	6.1	8.0
1990	4.9	13.3	5.1	20.6	11.4	50.6	7.5	15.1	5.8	9.0	6.7	8.7
1991	4.8	10.9	5.0	17.8	7.1	21.8	6.8	16.0	5.5	8.2	6.8	9.9
1992	4.4	13.8	4.9	15.5	8.7	23.9	10.9	15.2	4.5	5.3	5.1	6.8
1993	5.4	11.6	5.6	18.8	7.0	24.4	7.1	8.4	4.3	5.5	5.0	5.9
1994	5.8	12.0	5.4	17.8	8.2	25.4	10.0	14.1	5.3	8.5	6.6	9.6
1995	5.7	11.8	5.2	18.4	8.3	29.1	7.1	11.2	6.1	13.4	6.8	12.4
1996	4.5	9.3	4.8	17.2	8.0	24.1	6.1	8.9	5.7	11.1	5.9	8.1
1997	5.4	11.7	5.1	13.3	7.5	22.1	6.8	7.8	5.1	9.0	7.0	8.9
1998	5.1	19.1	5.3	22.1	7.0	23.1	6.8	13.5	6.0	20.6	8.0	9.3
1999	5.7	16.0	5.5	23.0	7.9	30.1	8.9	21.5	5.7	13.1	8.2	14.5
2000	5.4	12.2	5.5	15.9	8.8	15.9	7.8	12.0	5.7	10.1	8.3	17.8
2001	5.2	13.4	5.3	21.1	8.6	20.3	7.2	12.5	6.5	17.6	8.0	10.5
2002	5.1	12.7	5.5	19.6	8.9	23.3	8.8	15.5	7.5	14.4	8.3	13.1
2003	5.9	20.0	5.4	22.3	7.8	28.0	7.6	12.0	6.3	11.0	7.7	11.1
2004	6.8	25.7	5.6	23.2	7.5	17.4	9.5	11.9	7.2	10.3	9.7	13.7
2005	6.8	20.7	5.6	18.5	8.4	15.4	8.0	12.9	6.5	8.4	8.4	9.5
2006	5.4	16.7	5.8	19.1	7.5	19.2	6.7	15.0	4.7	5.6	8.4	12.0
2007	6.0	18.0	5.9	23.0	7.2	10.5	7.4	8.7	4.4	4.8	8.3	9.8
2008	5.6	17.2	6.1	21.0	7.0	15.0	8.7	14.8	5.0	9.6	7.9	13.9
2009	5.7	18.2	6.1	26.1	7.5	37.1	8.1	21.9	4.7	9.7	8.9	10.0
2010	8.9	20.2	6.6	26.3	7.5	20.7	7.6	13.8	5.5	8.2	8.3	10.2
2011	7.2	22.8	7.2	28.0	8.2	18.9	8.2	22.3	5.5	12.4	8.4	11.9
2012	7.7	22.0	7.7	25.9	8.6	25.7	8.1	23.7	6.1	17.3	8.1	10.0
2013	7.3	21.0	7.6	24.7	8.3	13.9	8.3	13.7	5.7	14.4	8.1	10.8

*Table 36. Results of GLM fall spawner catch and effort data (CPUE kg/net*hauls-day) analysis from landing statistics and telephone survey.*

Class	Levels	Values
Year	29	1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Area	8	1 2 3 4 5 6 7 8
Week	18	27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 48

Number of Observations Read	3803
Number of Observations Used	3775
Dependent variable	cpue

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	52	1367.015694	26.288763	59.58	<.0001
Error	3722	1642.304615	0.441243		
Corrected Total	3774	3009.320309			
Source	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Year	28	252.0123259	9.0004402	20.40	<.0001
Week	17	753.6262137	44.3309537	100.47	<.0001
Area	7	379.6290689	54.2327241	122.91	<.0001

R-Square (r^2)	Coef. Var.	Root MSE	cpue Mean
0.454261	11.77493	0.664261	5.641315

year	CPUE kg/net*hauls-day	year	CPUE kg/net*hauls-day
1986	170.6	2000	142.0
1987	132.2	2001	120.8
1988	112.2	2002	134.3
1989	175.7	2003	117.2
1990	105.3	2004	101.8
1991	148.1	2005	162.0
1992	138.4	2006	184.7
1993	126.3	2007	176.5
1994	97.4	2008	121.9
1995	72.1	2009	129.6
1996	83.7	2010	117.1
1997	126.6	2011	94.8
1998	93.7	2012	78.8
1999	96.5	2013	114.0

Table 37a. Fall spawner catch rate at age index from gillnets used in the ADAPT-VPA population models.

Year	4	5	6	7	8	9	10
1986	143.1	75.3	163.2	88.8	41.9	18.0	2.6
1987	94.3	75.8	54.4	95.9	40.4	26.1	11.8
1988	58.4	118.3	57.8	38.2	41.5	21.4	8.0
1989	73.3	119.8	158.1	78.0	35.7	45.0	17.7
1990	39.4	36.3	50.4	104.3	32.0	17.9	18.7
1991	211.4	56.5	43.0	58.3	72.6	27.2	15.8
1992	47.8	227.8	54.8	31.0	36.1	40.0	17.7
1993	14.9	170.8	202.5	32.2	16.1	16.4	8.4
1994	16.0	22.1	87.7	127.9	21.9	17.8	16.1
1995	5.0	54.9	22.6	67.1	64.8	11.9	8.5
1996	36.5	36.4	86.3	19.5	43.1	44.5	9.2
1997	62.7	229.9	48.2	75.7	13.9	24.6	23.2
1998	55.1	77.5	112.2	27.2	41.8	7.4	14.2
1999	80.1	143.7	81.6	48.9	11.0	15.2	3.7
2000	100.6	301.3	115.1	32.9	23.6	5.0	5.6
2001	80.3	172.7	160.7	55.8	12.4	6.3	1.6
2002	152.8	123.7	128.7	94.8	24.8	6.1	4.9
2003	54.0	189.2	68.8	70.1	63.5	14.5	4.6
2004	95.9	109.5	113.0	42.5	36.5	21.3	6.1
2005	24.0	255.7	167.9	135.4	42.6	34.2	14.3
2006	40.1	201.5	267.5	118.8	74.3	37.7	20.4
2007	26.5	112.9	233.4	236.3	97.9	29.9	18.4
2008	110.8	50.2	93.1	101.8	119.4	31.8	17.8
2009	95.8	213.0	70.3	111.3	47.7	18.9	17.5
2010	18.9	129.3	198.1	58.2	54.7	36.8	18.2
2011	6.2	41.2	118.9	166.7	35.2	24.0	18.6
2012	0.8	29.4	92.1	131.3	85.5	14.1	9.6
2013	7.4	42.7	171.6	194.1	90.2	32.4	1.8

Table 37b. Fall spawner acoustic survey index at age used in the ADAPT-VPA population models.

Year	2	3	4	5	6	7	8	9
1994	2.2	4.4	201.4	62.0	33.1	17.3	2.3	0.0
1995	12.3	22.3	11.6	50.0	9.3	15.8	23.6	1.8
1996	225.8	241.0	163.9	22.0	72.9	16.4	9.7	4.0
1997	66.8	306.8	200.4	69.4	8.4	32.1	9.6	8.2
1998	66.6	190.6	74.4	45.3	28.0	5.2	22.8	3.2
1999	59.7	308.3	191.4	63.4	32.5	16.0	2.5	4.8
2000	55.5	128.0	188.2	137.9	40.0	13.2	6.6	2.4
2001	96.9	32.8	12.9	10.0	8.6	1.4	0.8	0.2
2002	166.0	32.2	31.3	20.4	27.8	16.1	4.7	0.7
2003	50.1	255.4	67.5	20.0	5.8	6.7	8.0	1.6
2004	29.5	69.6	53.1	10.9	2.2	0.1	0.3	0.0
2005	29.1	62.8	253.8	138.4	31.8	10.9	4.1	4.1
2006	220.7	75.1	43.1	75.2	51.0	7.3	1.4	0.8
2007	78.6	147.3	42.1	19.6	11.1	7.5	0.1	0.7
2008	71.7	91.0	50.4	7.6	4.7	5.2	3.3	0.5
2009	71.7	112.0	80.9	39.8	5.6	1.6	0.8	0.1
2010	34.6	107.0	113.7	94.3	25.0	4.0	1.3	0.2
2011	28.9	41.7	86.4	67.8	51.3	22.5	4.8	2.9
2012	0.4	265.4	110.1	101.6	53.9	19.3	1.5	2.8
2013	4.0	18.8	170.1	69.7	97.9	40.8	10.8	7.7

Table 38. Proportions at age in the fall spawner fixed gear catches.

Year	4	5	6	7	8	9	10	11
1978	0.29	0.21	0.05	0.05	0.26	0.00	0.01	0.13
1979	0.49	0.24	0.12	0.03	0.04	0.04	0.01	0.03
1980	0.28	0.40	0.07	0.15	0.03	0.04	0.03	0.01
1981	0.65	0.19	0.07	0.03	0.03	0.00	0.01	0.01
1982	0.35	0.41	0.13	0.07	0.03	0.01	0.00	0.00
1983	0.42	0.21	0.28	0.05	0.04	0.01	0.00	0.01
1984	0.42	0.26	0.16	0.11	0.03	0.01	0.00	0.00
1985	0.09	0.42	0.22	0.12	0.11	0.04	0.01	0.00
1986	0.27	0.14	0.30	0.17	0.08	0.03	0.00	0.01
1987	0.23	0.19	0.13	0.24	0.10	0.06	0.03	0.01
1988	0.17	0.34	0.16	0.11	0.12	0.06	0.02	0.02
1989	0.14	0.22	0.29	0.14	0.07	0.08	0.03	0.02
1990	0.13	0.12	0.16	0.34	0.10	0.06	0.06	0.04
1991	0.41	0.11	0.08	0.11	0.14	0.05	0.03	0.05
1992	0.10	0.47	0.11	0.06	0.07	0.08	0.04	0.06
1993	0.03	0.36	0.43	0.07	0.03	0.03	0.02	0.03
1994	0.05	0.07	0.26	0.38	0.06	0.05	0.05	0.08
1995	0.02	0.22	0.09	0.26	0.25	0.05	0.03	0.08
1996	0.12	0.12	0.29	0.07	0.15	0.15	0.03	0.07
1997	0.13	0.47	0.10	0.15	0.03	0.05	0.05	0.03
1998	0.15	0.22	0.32	0.08	0.12	0.02	0.04	0.06
1999	0.20	0.37	0.21	0.13	0.03	0.04	0.01	0.02
2000	0.17	0.51	0.20	0.06	0.04	0.01	0.01	0.01
2001	0.16	0.35	0.33	0.11	0.03	0.01	0.00	0.01
2002	0.28	0.23	0.24	0.18	0.05	0.01	0.01	0.01
2003	0.12	0.40	0.15	0.15	0.14	0.03	0.01	0.01
2004	0.22	0.26	0.26	0.10	0.09	0.05	0.01	0.01
2005	**0.04**	**0.38**	0.25	0.20	0.06	0.05	0.02	0.00
2006	**0.05**	**0.26**	0.35	0.15	0.10	0.05	0.03	0.01
2007	**0.03**	**0.15**	0.31	0.31	0.13	0.04	0.02	0.01
2008	**0.21**	**0.09**	0.17	0.19	0.22	0.06	0.03	0.02
2009	**0.16**	**0.37**	0.12	0.19	0.08	0.03	0.03	0.02
2010	**0.04**	**0.25**	0.38	0.11	0.10	0.07	0.03	0.02
2011	**0.01**	**0.10**	0.28	0.39	0.08	0.06	0.04	0.03
2012	**0.00**	**0.08**	0.25	0.35	0.23	0.04	0.03	0.02
2013	**0.01**	**0.08**	0.32	0.36	0.17	0.06	0.00	0.00

Table 39. MODEL 1 diagnostics of fall spawner ADAPT-VPA results using the gillnet CPUE age-disaggregated indices and the acoustic survey index (ages 2-3) in the model formulations (parameters are in linear scale).

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION: MEAN SQUARE RESIDUALS = 0.449

Parameter	Parameter estimate	Standard error	Relative error	Bias	Relative bias
Population estimates in 2014					
N[2014 3]	35611	24619	0.691	8623	0.242
N[2014 4]	13625	6754	0.496	1701	0.125
N[2014 5]	174242	70976	0.407	14702	0.084
N[2014 6]	37249	16396	0.44	3038	0.082
N[2014 7]	68657	32836	0.478	5828	0.085
N[2014 8]	58584	31212	0.533	5752	0.098
N[2014 9]	84403	33239	0.394	6192	0.073
N[2014 10]	62966	25529	0.405	4656	0.074
Catchability - Gillnet CPUE disaggregated ages 4-10					
q CPUE age 4	0.000152	0.000020	0.129	0.000001	0.006
q CPUE age 5	0.000554	0.000071	0.129	0.000004	0.007
q CPUE age 6	0.000865	0.000111	0.129	0.000006	0.007
q CPUE age 7	0.001118	0.000144	0.129	0.000010	0.009
q CPUE age 8	0.001128	0.000146	0.129	0.000010	0.009
q CPUE age 9	0.001073	0.000139	0.129	0.000011	0.010
q CPUE age 10	0.001057	0.000136	0.129	0.000011	0.011
Acoustic survey disaggregated ages 2-3					
q Acoust. age 2	0.000106	0.000017	0.16	0.000001	0.009
q Acoust. age 3	0.000281	0.000044	0.156	0.000002	0.009

Table 40. MODEL 1: Fall spawner population numbers (x1000) at age at beginning of year from the ADAPT calibration using the gillnet CPUE age disaggregated indices and the acoustic survey index (ages 2-3) in the model.

Year	2	3	4	5	6	7	8	9	10	11+	Total 4-11
1978	136402	135162	79596	57539	14721	18461	32397	7050	2980	42612	255356
1979	416240	110419	89375	39426	24477	7374	9733	8902	4044	18102	201433
1980	350819	335400	81797	56399	22707	11009	3530	4147	3045	5299	187933
1981	494832	284509	230268	48839	21069	8428	2630	873	633	3120	315860
1982	694824	404065	218404	155943	32773	14468	5391	1038	394	2531	430942
1983	379538	567954	320892	162677	106105	21411	9192	3251	404	1910	625842
1984	488778	310539	459105	237846	121536	70705	14738	5750	1946	1492	913118
1985	730333	399818	252472	349559	176622	88927	50482	10300	4113	2471	934946
1986	452822	597647	325444	198543	252492	124668	62321	32435	4519	4175	1004597
1987	293443	370080	485646	235284	144592	168533	81051	41194	21490	5334	1183124
1988	309870	238761	292150	362786	165374	98313	101471	48865	23916	14871	1107746
1989	1062601	250132	192009	216927	254113	114462	64661	66514	31803	23983	964472
1990	649636	869236	203522	142357	152647	176243	78326	44654	44143	37799	879691
1991	199305	531800	704527	143374	94648	97333	89327	46369	25546	50361	1251485
1992	523543	163176	430616	524688	104220	69153	68077	59569	33023	52245	1341591
1993	193018	428601	132978	337415	368694	70880	48120	46702	38681	54157	1097627
1994	511640	157749	346876	104003	244243	262064	50721	35075	33960	67240	1144182
1995	327515	418881	128895	268332	70844	147197	139225	29153	18252	57811	859709
1996	505487	268127	340792	98626	163714	36787	65977	60547	13914	39868	820225
1997	847540	413507	217070	249356	57952	82756	17059	30346	26281	28126	708946
1998	656335	693519	333147	156246	137681	33176	44656	9667	17446	33632	765651
1999	486667	537316	566349	248899	95355	66983	16238	18654	4803	26486	1043767
2000	723394	397805	432396	417494	133686	38804	28546	5998	6793	19140	1082857
2001	659316	591335	319232	309977	233267	68880	19573	14797	3025	17918	986669
2002	909318	537972	471701	227466	186666	128845	35181	10200	9036	14866	1083961
2003	621934	743555	435967	330247	141186	108113	71882	20096	6123	16250	1129864
2004	447561	509015	600657	322711	189490	83427	55557	28686	8863	13926	1303317
2005	282901	365963	412584	447141	223066	114885	52037	31864	15075	15136	1311788
2006	1098029	230761	295599	314657	278001	129195	53581	29550	15518	19608	1135709
2007	889317	898049	186754	229123	201785	158802	76127	25802	14945	21964	915302
2008	507667	726764	720854	142450	159865	110317	76136	40162	14379	24303	1288466
2009	330788	414391	585811	553168	100638	103328	60550	27604	23727	22937	1477763
2010	109051	270664	334135	444341	384353	60265	49889	34703	16699	29951	1354336
2011	302802	89278	219898	260978	311584	242976	29102	22309	16172	29184	1132203
2012	18355	246851	72417	175962	197047	210973	139464	11213	9860	25543	842479
2013	33544	14990	201744	58656	132298	126781	124379	82701	4045	22725	753329
2014	275555*	26988	11924	159540	34211	62830	52832	78211	58309	20988	478845

* SSB 2012 multiplied by mean (2007-2013) age 2 survival ratio (number / SSB)

Table 41. MODEL 1: Fall spawner population biomass (t) at age at beginning of year from the ADAPT calibration using the gillnet CPUE age disaggregated indices and the acoustic survey index (ages 2-3) in the model.

Year	2	3	4	5	6	7	8	9	10	11+	Total 4-11
1978	10068	15736	15617	13688	4016	5001	10530	2253	873	16566	68544
1979	46564	14788	16806	9674	6769	2178	3147	3182	1418	6331	49505
1980	29062	45590	15123	13649	6012	3273	1145	1543	1170	2092	44007
1981	45355	41844	44377	11703	6210	2645	908	305	271	1316	67734
1982	48771	57831	49088	41798	10320	5277	2050	410	148	1148	110238
1983	29402	72680	65762	43210	31725	7140	3446	1204	151	798	153436
1984	32924	42342	93250	60332	35320	22844	5331	2249	746	624	220697
1985	47019	54116	51875	90856	51934	29200	17894	4039	1723	1070	248591
1986	54423	74689	70288	51088	75454	41969	22739	12249	1854	1793	277434
1987	25734	66221	100547	61419	42957	55355	29348	15807	8334	2259	316026
1988	21765	34120	69066	96134	49531	32093	36135	18544	9437	5960	316900
1989	77380	32072	40873	58549	76406	37911	22741	24818	12590	9774	283662
1990	63012	116517	41528	37285	46219	58424	27745	16566	17159	15629	260554
1991	14981	69145	140403	35240	26749	31502	30978	16865	9560	20147	311445
1992	27922	18430	75952	121526	27323	20302	22437	20516	11734	19437	319228
1993	11022	41088	20771	74352	92698	19403	14588	15594	13040	19463	269909
1994	37739	15917	53465	21255	59163	70013	14770	11233	11631	23875	265405
1995	17516	42393	20324	53282	16239	38280	39332	9217	6249	21076	203999
1996	35143	26296	52274	20400	37685	9204	18795	18362	4694	14773	176187
1997	55375	47517	34917	53132	14036	21208	4788	9358	8611	10380	156429
1998	38064	70626	58171	32979	33334	8891	12283	2995	5670	11921	166243
1999	25566	53093	89575	54343	22592	17595	4644	5446	1596	9105	204896
2000	42599	38727	69209	88374	32391	9999	8078	1803	2097	6690	218641
2001	37179	59005	51861	65850	55200	17936	5398	4365	940	5650	207200
2002	59239	58714	78188	49260	44847	33629	9801	3042	2771	4843	226381
2003	39621	80225	74342	72345	34052	27922	20149	5934	1969	5345	242057
2004	28735	52422	97375	65695	44049	20956	15032	8289	2682	4540	258618
2005	16973	36613	60708	90651	50271	27975	13746	8967	4444	4781	261543
2006	68089	23555	45451	59252	63028	31313	13660	8260	4478	5954	231397
2007	74766	90127	28659	44596	44002	37677	18882	6721	4141	6399	191077
2008	33805	63766	106531	24217	29639	21891	16248	9439	3772	6706	218443
2009	26832	53811	117047	114686	25361	27572	16948	7808	6383	6124	321929
2010	9714	28242	46934	83547	78836	13960	12394	9035	4572	8369	257648
2011	16870	8829	29480	43639	63148	52252	6958	5707	4229	8065	213479
2012	1139	21313	8760	29074	37339	44713	30773	2740	2549	6848	162795
2013	2190	1401	24818	9382	24989	25810	27269	18638	1011	5939	137855
2014	16811	2507	1503	26186	6626	13206	11957	18915	14964	5637	98993

Table 42. MODEL 1 fall spawner fishing mortality at age for the ADAPT calibration using the gillnet CPUE age disaggregated indices and the acoustic survey index (ages 2-3) in the model.

Year	2	3	4	5	6	7	8	9	10	11+	Mean 5 to 10
1978	0.011	0.214	0.503	0.655	0.491	0.44	1.092	0.356	0.724	0.724	0.699
1979	0.016	0.1	0.26	0.352	0.599	0.537	0.653	0.873	0.763	1.373	0.529
1980	0.01	0.176	0.316	0.785	0.791	1.232	1.197	1.68	1.438	0.54	0.906
1981	0.003	0.064	0.19	0.199	0.176	0.247	0.729	0.596	0.663	0.121	0.223
1982	0.002	0.03	0.095	0.185	0.226	0.254	0.306	0.744	0.525	0.187	0.203
1983	0.001	0.013	0.099	0.092	0.206	0.174	0.269	0.313	0.291	0.228	0.146
1984	0.001	0.007	0.073	0.098	0.112	0.137	0.158	0.135	0.147	0.109	0.110
1985	0.001	0.006	0.04	0.125	0.148	0.156	0.242	0.624	0.433	0.016	0.153
1986	0.002	0.008	0.124	0.117	0.204	0.231	0.214	0.212	0.213	0.378	0.185
1987	0.006	0.036	0.092	0.153	0.186	0.307	0.306	0.344	0.325	0.705	0.232
1988	0.014	0.018	0.098	0.156	0.168	0.219	0.222	0.23	0.226	0.376	0.181
1989	0.001	0.006	0.099	0.151	0.166	0.179	0.17	0.21	0.19	0.188	0.169
1990	0	0.01	0.15	0.208	0.25	0.48	0.324	0.358	0.341	0.227	0.327
1991	0	0.011	0.095	0.119	0.114	0.158	0.205	0.139	0.172	0.174	0.146
1992	0	0.005	0.044	0.153	0.186	0.163	0.177	0.232	0.204	0.287	0.167
1993	0.002	0.012	0.046	0.123	0.141	0.135	0.116	0.119	0.117	0.126	0.130
1994	0	0.002	0.057	0.184	0.306	0.432	0.354	0.453	0.403	0.339	0.349
1995	0	0.006	0.068	0.294	0.455	0.602	0.633	0.54	0.586	0.406	0.467
1996	0.001	0.011	0.112	0.332	0.482	0.568	0.577	0.635	0.606	0.399	0.495
1997	0.001	0.016	0.129	0.394	0.358	0.417	0.368	0.354	0.361	0.212	0.388
1998	0	0.003	0.092	0.294	0.52	0.514	0.673	0.499	0.586	0.396	0.450
1999	0.002	0.017	0.105	0.422	0.699	0.653	0.796	0.81	0.803	0.221	0.548
2000	0.002	0.02	0.133	0.382	0.463	0.484	0.457	0.484	0.471	0.081	0.411
2001	0.003	0.026	0.139	0.307	0.394	0.472	0.452	0.293	0.373	0.109	0.360
2002	0.001	0.01	0.157	0.277	0.346	0.384	0.36	0.31	0.335	0.105	0.328
2003	0	0.013	0.101	0.356	0.326	0.466	0.719	0.619	0.669	0.158	0.416
2004	0.001	0.01	0.095	0.169	0.3	0.272	0.356	0.443	0.4	0.104	0.247
2005	0.004	0.014	0.071	0.275	0.346	0.563	0.366	0.519	0.443	0.059	0.347
2006	0.001	0.012	0.055	0.244	0.36	0.329	0.531	0.482	0.506	0.115	0.329
2007	0.002	0.02	0.071	0.16	0.404	0.535	0.439	0.385	0.412	0.104	0.358
2008	0.003	0.016	0.065	0.147	0.236	0.4	0.815	0.326	0.57	0.2	0.343
2009	0.001	0.015	0.076	0.164	0.313	0.528	0.357	0.303	0.33	0.161	0.247
2010	0	0.008	0.047	0.155	0.259	0.528	0.605	0.564	0.584	0.129	0.262
2011	0.004	0.009	0.023	0.081	0.19	0.355	0.754	0.617	0.685	0.236	0.242
2012	0.003	0.002	0.011	0.085	0.241	0.328	0.323	0.82	0.571	0.141	0.257
2013	0.017	0.029	0.035	0.339	0.545	0.675	0.264	0.149	0.207	0.017	0.423

Table 43. MODEL 1 input parameters for 2014 fall spawner catch projections from the ADAPT calibration using the gillnet CPUE age disaggregated index and the acoustic survey index (ages 2-3) in the model formulations.

Age	Maturity	Natural mortality	Partial recruitment	Beginning of year weight (kg)	Mean weight (kg)	Population numbers (X 1000) January 2014
2	0	0.2	0.007	0.071	0.074	275,555
3	0	0.2	0.03	0.102	0.109	26,988
4	1	0.2	0.10	0.123	0.144	11,924
5	1	0.2	0.51	0.164	0.181	159,540
6	1	0.2	1	0.194	0.202	34,211
7	1	0.2	1	0.210	0.214	62,830
8	1	0.2	1	0.226	0.230	52,832
9	1	0.2	1	0.242	0.245	78,211
10	1	0.2	1	0.257	0.258	58,309
11+	1	0.2	1	0.269	0.271	20,988

Table 44. MODEL 1 fall spawner catch and population projections from the ADAPT calibration using the gillnet CPUE age disaggregated index and the acoustic survey index (ages 2-3) in the model formulations.

Age	Catch numbers (X 1000) 2014	Catch biomass (t) 2014	Population numbers (X 1000) 2015	Population biomass (t) 2015
2	559	41	275555	19564
3	234	25	225101	22960
4	341	49	21884	2692
5	21833	3952	9455	1551
6	8536	1724	110952	21525
7	15678	3355	20339	4271
8	13183	3032	37354	8442
9	19516	4781	31410	7601
10	14550	3754	46498	11950
11+	5237	1419	47144	12682
2+	-	22133	-	113238
3+	-	22092	-	93673
4+	-	22067	-	70713

Table 45. MODEL 2 SPLIT CPUE Diagnostics of fall spawner ADAPT-VPA results using the split gillnet CPUE age- disaggregated indices and the acoustic survey index (ages 2-3) in the model formulations (parameters are in linear scale).

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION MEAN SQUARE RESIDUALS = 0.387

Parameter	Parameter estimate	Standard error	Relative error	Bias	Relative bias
Population estimates in 2014					
N[2014 3]	41073	26387	0.642	8592	0.209
N[2014 4]	15659	7209	0.46	1689	0.108
N[2014 5]	429783	173500	0.404	37191	0.087
N[2014 6]	98114	39177	0.399	7754	0.079
N[2014 7]	140291	55464	0.395	9506	0.068
N[2014 8]	98535	42646	0.433	6909	0.07
N[2014 9]	113262	39046	0.345	6605	0.058
N[2014 10]	77341	27659	0.358	4582	0.059
Catchability Split Gillnet CPUE disaggregated ages 4-10					
1986-2013					
q CPUE age 6	0.000152	0.000020	0.129	0.000001	0.006
q CPUE age 7	0.000554	0.000071	0.129	0.000004	0.007
q CPUE age 8	0.000865	0.000111	0.129	0.000006	0.007
q CPUE age 9	0.001118	0.000144	0.129	0.000010	0.009
q CPUE age 10	0.001128	0.000146	0.129	0.000010	0.009
1986-2003					
q CPUE age 4	0.000213	0.000031	0.147	0.00000	0.011
q CPUE age 5	0.000601	0.000088	0.147	0.00001	0.011
2004-2013					
q CPUE age 4	0.000278	0.000104	0.374	0.00002	0.069
Trend q age 4	0.72	0.054516	0.076	0.00126	0.002
q CPUE age 5	0.000786	0.000293	0.372	0.00005	0.069
trend q age 5	0.86	0.063826	0.074	0.00149	0.002
Acoustic survey disaggregated ages 2-3					
q Acoust. age 2	0.000092	0.000014	0.152	0.00000	0.008
q Acoust. age 3	0.000246	0.000036	0.148	0.00000	0.008

Table 46. MODEL 2: SPLIT CPUE Fall spawner population numbers (x1000) at age at the beginning of year from ADAPT calibration using the split gillnet CPUE age disaggregated indices and the acoustic survey index (ages 2-3) in the model.

Year	2	3	4	5	6	7	8	9	10	11+	Total 4-11
1978	136402	135162	79596	57539	14721	18461	32397	7050	2980	42612	255356
1979	416240	110419	89375	39426	24477	7374	9733	8902	4044	18102	201433
1980	350820	335400	81797	56399	22707	11009	3530	4147	3045	5299	187933
1981	494833	284510	230269	48839	21069	8428	2630	873	633	3120	315861
1982	694825	404065	218404	155943	32773	14468	5391	1038	394	2531	430942
1983	379540	567955	320893	162677	106105	21411	9192	3251	404	1910	625843
1984	488780	310540	459106	237847	121537	70705	14738	5750	1946	1492	913121
1985	730335	399819	252473	349560	176622	88927	50483	10300	4113	2471	934949
1986	452825	597649	325445	198543	252492	124668	62321	32435	4519	4175	1004598
1987	293445	370082	485648	235285	144592	168534	81051	41194	21490	5334	1183128
1988	309873	238763	292152	362787	165374	98314	101472	48865	23916	14872	1107752
1989	1062612	250134	192010	216928	254114	114462	64661	66515	31803	23983	964476
1990	649646	869245	203524	142359	152648	176244	78326	44654	44143	37799	879697
1991	199310	531809	704535	143376	94650	97334	89328	46370	25546	50362	1251501
1992	523559	163180	430623	524694	104221	69153	68078	59569	33024	52245	1341607
1993	193029	428614	132982	337420	368699	70882	48121	46702	38681	54158	1097645
1994	511687	157758	346887	104006	244247	262068	50722	35076	33961	67241	1144208
1995	327559	418920	128902	268341	70846	147200	139229	29154	18253	57813	859738
1996	505610	268163	340824	98632	163721	36789	65980	60550	13914	39870	820280
1997	847866	413607	217099	249382	57957	82762	17060	30349	26283	28127	709019
1998	656839	693787	333230	156270	137703	33180	44661	9668	17448	33635	765795
1999	487511	537729	566568	248966	95375	67001	16242	18658	4804	26490	1044104
2000	724470	398496	432734	417674	133741	38820	28560	6001	6797	19144	1083471
2001	662426	592216	319798	310253	233414	68925	19586	14808	3027	17924	987735
2002	912484	540518	472422	227929	186892	128965	35218	10211	9045	14873	1085555
2003	626969	746148	438051	330837	141565	108298	71980	20126	6132	16263	1133252
2004	454115	513137	602779	324417	189972	83736	55708	28765	8887	13944	1308208
2005	288186	371329	415959	448879	224462	115279	52291	31987	15139	15171	1319167
2006	1169969	235088	299992	317420	279421	130336	53902	29756	15619	19689	1146135
2007	1005049	956949	190297	232720	204045	159963	77059	26064	15114	22112	927374
2008	637216	821517	769077	145350	162808	112162	77082	40923	14592	24562	1346556
2009	516026	520457	663388	592647	103012	105736	62057	28370	24349	23324	1602883
2010	234113	422324	420974	507850	416662	62205	51852	35934	17325	30775	1543577
2011	727454	191670	344066	332074	363563	269402	30683	23907	17175	30369	1411239
2012	21408	594526	156248	277622	255250	253509	161059	12497	11161	27328	1154674
2013	40254	17489	486396	127291	215524	174399	159154	100356	5086	25245	1293451
2014	532310*	32482	13970	392592	90360	130786	91626	106657	72760	23904	922655

* SSB 2012 multiplied by mean (2007-2013) age 2 survival ratio (number / SSB)

Table 47. MODEL 2 SPLIT CPUE Fall spawner population biomass (t) at age at the beginning of year from ADAPT calibration using the split gillnet CPUE age disaggregated indices and the acoustic survey index (ages 2-3) in the model.

Year	2	3	4	5	6	7	8	9	10	11+	Total 4-11
1978	10068	15736	15617	13688	4016	5001	10530	2253	873	16566	68544
1979	46564	14788	16806	9674	6769	2178	3147	3182	1418	6331	49505
1980	29062	45590	15123	13649	6012	3273	1145	1543	1170	2092	44007
1981	45365	41844	44377	11703	6210	2645	908	305	271	1316	67735
1982	48771	57831	49088	41798	10320	5277	2050	410	148	1148	110238
1983	29403	72680	65762	43210	31725	7140	3446	1204	151	798	153436
1984	32924	42342	93250	60333	35321	22844	5331	2249	746	624	220698
1985	47020	54116	51875	90856	51934	29200	17894	4039	1723	1070	248591
1986	54424	74689	70288	51088	75454	41969	22739	12249	1854	1793	277434
1987	25734	66222	100548	61420	42957	55355	29348	15807	8334	2259	316027
1988	21765	34120	69067	96134	49531	32093	36135	18544	9437	5960	316901
1989	77381	32072	40873	58549	76406	37911	22741	24818	12590	9774	283663
1990	63013	116519	41528	37285	46219	58424	27745	16566	17159	15629	260555
1991	14981	69146	140405	35241	26749	31502	30978	16866	9560	20148	311449
1992	27923	18430	75953	121528	27323	20302	22438	20516	11735	19437	319232
1993	11022	41089	20772	74353	92700	19404	14588	15594	13040	19463	269913
1994	37742	15918	53467	21255	59164	70014	14770	11233	11631	23876	265411
1995	17519	42397	20325	53284	16239	38281	39333	9217	6250	21077	204006
1996	35151	26300	52279	20402	37687	9205	18795	18362	4694	14774	176198
1997	55396	47528	34922	53138	14037	21210	4788	9359	8611	10380	156445
1998	38093	70653	58185	32984	33340	8892	12284	2995	5671	11922	166273
1999	25610	53134	89610	54358	22597	17600	4645	5447	1596	9106	204959
2000	42662	38795	69263	88412	32404	10003	8082	1804	2099	6691	218758
2001	37355	59093	51953	65909	55235	17948	5402	4368	941	5651	207406
2002	59445	58992	78308	49361	44901	33660	9811	3046	2773	4845	226705
2003	39942	80505	74697	72474	34143	27970	20176	5943	1972	5349	242724
2004	29156	52847	97719	66042	44162	21034	15073	8311	2689	4546	259576
2005	17290	37150	61205	91004	50586	28070	13813	9002	4463	4792	262934
2006	72550	23997	46127	59773	63349	31590	13742	8318	4507	5979	233385
2007	84496	96038	29203	45296	44495	37952	19113	6789	4188	6442	193478
2008	42431	72080	113658	24710	30185	22257	16449	9618	3828	6777	227482
2009	41858	67585	132548	122871	25960	28214	17370	8024	6550	6228	347765
2010	20853	44067	59132	95489	85463	14409	12882	9356	4744	8599	290074
2011	40529	18954	46127	55527	73683	57935	7335	6116	4491	8392	259607
2012	1328	51332	18900	45871	48368	53728	35538	3054	2886	7326	215671
2013	2628	1634	59835	20361	40709	35504	34893	22617	1271	6597	221786
2014	32476	3017	1760	64437	17501	27490	20737	25794	18672	6420	182812

Table 48. MODEL 2 SPLIT CPUE Fall spawner fishing mortality at age for the ADAPT calibration using the split gillnet CPUE age disaggregated indices and the acoustic survey index (ages 2-3) in the model.

Year	2	3	4	5	6	7	8	9	10	11+	Mean 5 to 10
1978	0.011	0.214	0.503	0.655	0.491	0.44	1.092	0.356	0.724	0.724	0.699
1979	0.016	0.1	0.26	0.352	0.599	0.537	0.653	0.873	0.763	1.373	0.529
1980	0.01	0.176	0.316	0.785	0.791	1.232	1.197	1.68	1.438	0.54	0.906
1981	0.003	0.064	0.19	0.199	0.176	0.247	0.729	0.596	0.663	0.121	0.223
1982	0.002	0.03	0.095	0.185	0.226	0.254	0.306	0.744	0.525	0.187	0.203
1983	0.001	0.013	0.099	0.092	0.206	0.174	0.269	0.313	0.291	0.228	0.146
1984	0.001	0.007	0.073	0.098	0.112	0.137	0.158	0.135	0.147	0.109	0.110
1985	0.001	0.006	0.04	0.125	0.148	0.156	0.242	0.624	0.433	0.016	0.153
1986	0.002	0.008	0.124	0.117	0.204	0.231	0.214	0.212	0.213	0.378	0.185
1987	0.006	0.036	0.092	0.153	0.186	0.307	0.306	0.344	0.325	0.705	0.232
1988	0.014	0.018	0.098	0.156	0.168	0.219	0.222	0.23	0.226	0.376	0.181
1989	0.001	0.006	0.099	0.151	0.166	0.179	0.17	0.21	0.19	0.188	0.169
1990	0	0.01	0.15	0.208	0.25	0.48	0.324	0.358	0.341	0.227	0.327
1991	0	0.011	0.095	0.119	0.114	0.157	0.205	0.139	0.172	0.174	0.146
1992	0	0.005	0.044	0.153	0.186	0.163	0.177	0.232	0.204	0.287	0.167
1993	0.002	0.012	0.046	0.123	0.141	0.135	0.116	0.119	0.117	0.126	0.130
1994	0	0.002	0.057	0.184	0.306	0.432	0.354	0.453	0.403	0.339	0.349
1995	0	0.006	0.068	0.294	0.455	0.602	0.633	0.54	0.586	0.405	0.467
1996	0.001	0.011	0.112	0.332	0.482	0.568	0.577	0.635	0.606	0.399	0.495
1997	0.001	0.016	0.129	0.394	0.358	0.417	0.368	0.354	0.361	0.212	0.388
1998	0	0.003	0.092	0.294	0.52	0.514	0.673	0.499	0.586	0.396	0.450
1999	0.002	0.017	0.105	0.421	0.699	0.653	0.796	0.81	0.803	0.221	0.548
2000	0.002	0.02	0.133	0.382	0.463	0.484	0.457	0.484	0.47	0.081	0.411
2001	0.003	0.026	0.139	0.307	0.393	0.471	0.451	0.293	0.372	0.109	0.360
2002	0.001	0.01	0.156	0.276	0.346	0.383	0.36	0.31	0.335	0.105	0.327
2003	0	0.013	0.1	0.355	0.325	0.465	0.717	0.617	0.667	0.158	0.415
2004	0.001	0.01	0.095	0.168	0.3	0.271	0.355	0.442	0.398	0.104	0.246
2005	0.004	0.013	0.07	0.274	0.344	0.56	0.364	0.517	0.44	0.059	0.346
2006	0.001	0.011	0.054	0.242	0.358	0.326	0.527	0.477	0.502	0.115	0.326
2007	0.002	0.019	0.069	0.157	0.398	0.53	0.433	0.38	0.406	0.104	0.352
2008	0.002	0.014	0.061	0.144	0.232	0.392	0.8	0.319	0.559	0.198	0.336
2009	0	0.012	0.067	0.152	0.304	0.513	0.346	0.293	0.32	0.159	0.233
2010	0	0.005	0.037	0.134	0.236	0.507	0.574	0.538	0.556	0.125	0.235
2011	0.002	0.004	0.015	0.063	0.161	0.314	0.698	0.562	0.63	0.226	0.202
2012	0.002	0.001	0.005	0.053	0.181	0.266	0.273	0.699	0.486	0.131	0.192
2013	0.015	0.025	0.014	0.143	0.3	0.444	0.2	0.122	0.161	0.015	0.262

Table 49. MODEL 2 SPLIT CPUE Input parameters for 2014 fall spawner catch projections from the ADAPT calibration using the split gillnet CPUE age disaggregated index and the acoustic survey index (ages 2-3) in the model formulations.

Age	Maturity	Natural mortality	Partial recruitment	Beginning of year weight (kg)	Mean weight (kg)	Population numbers (X 1000) January 2014
2	0	0.2	0.003	0.071	0.074	532,310
3	0	0.2	0.02	0.102	0.109	32,482
4	1	0.2	0.08	0.123	0.144	13,970
5	1	0.2	0.43	0.164	0.181	392,592
6	1	0.2	1	0.194	0.202	90,360
7	1	0.2	1	0.210	0.214	130,786
8	1	0.2	1	0.226	0.230	91,626
9	1	0.2	1	0.242	0.245	106,657
10	1	0.2	1	0.257	0.258	72,760
11+	1	0.2	1	0.269	0.271	23,904

Table 50. MODEL 2 SPLIT CPUE Fall spawner catch and population projections from the ADAPT calibration using the gillnet CPUE age disaggregated index and the acoustic survey index (ages 2-3) in the model formulations.

Age	Catch numbers (X 1000) 2014	Catch biomass (t) 2014	Population numbers (X 1000) 2015	Population biomass (t) 2015
2	463	34	532,310	37,794
3	188	20	435,400	44,411
4	320	46	26,424	3,250
5	45,847	8,298	11,149	1,828
6	22,547	4,555	280,107	54,341
7	32,634	6,984	53,721	11,281
8	22,863	5,258	77,755	17,573
9	26,614	6,520	54,473	13,183
10	18,155	4,684	63,410	16,296
11+	5,965	1,616	57,468	15,459
2+	-	38,017	-	215,416
3+	-	37,983	-	177,622
4+	-	37,962	-	133,211

FIGURES

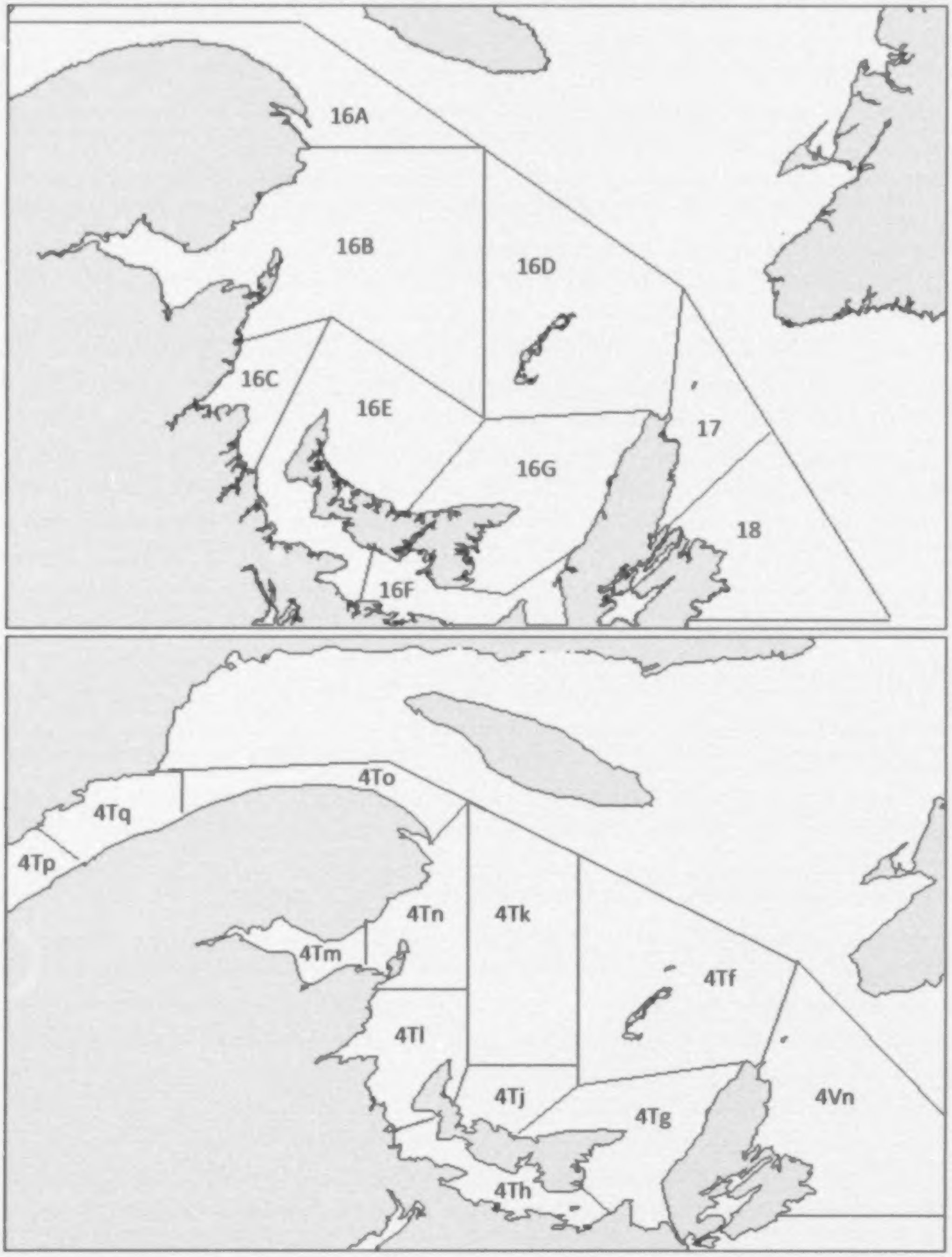

16A
16B
16D
16C
16E
16G
17
18
16F
4To
4Tq
4Tp
4Tn
4Tk
4Tm
4Tf
4Tl
4Tj
4Tg
4Vn
4Th

Figure 1. Southern Gulf of St. Lawrence herring fishery management zones (upper) and Northwest Atlantic Fisheries Organization (NAFO) divisions 4T and 4Vn with 4T unit areas (lower).

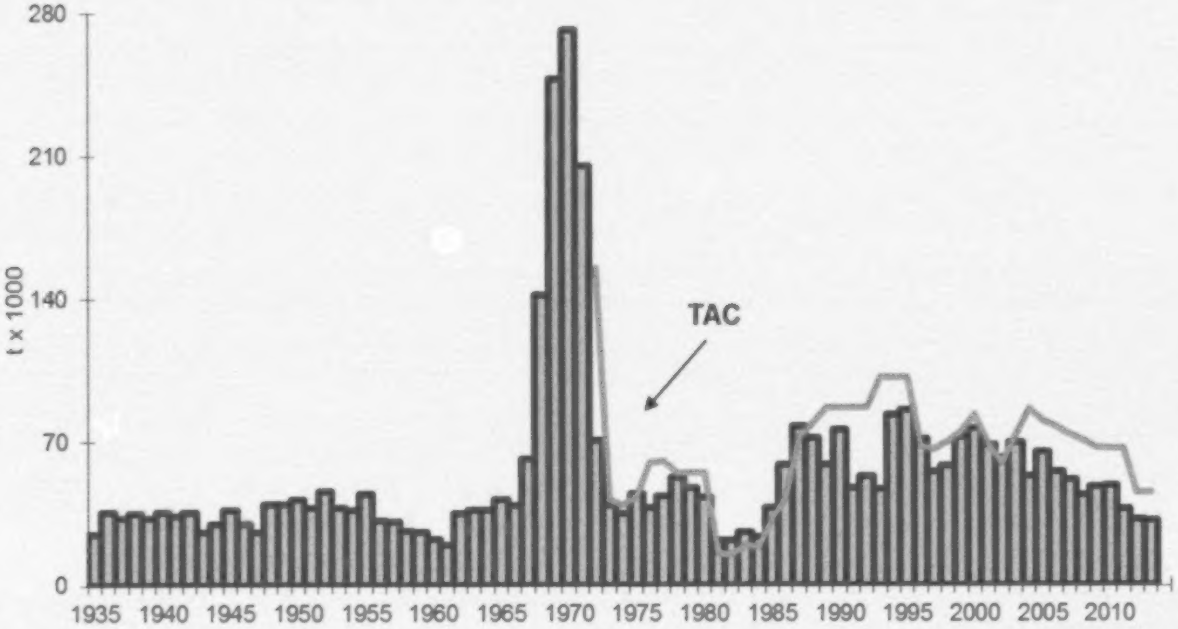


Figure 2. Combined spring and fall 4T herring landings compared to the overall spring and fall 4T TAC (last two year's data are preliminary).

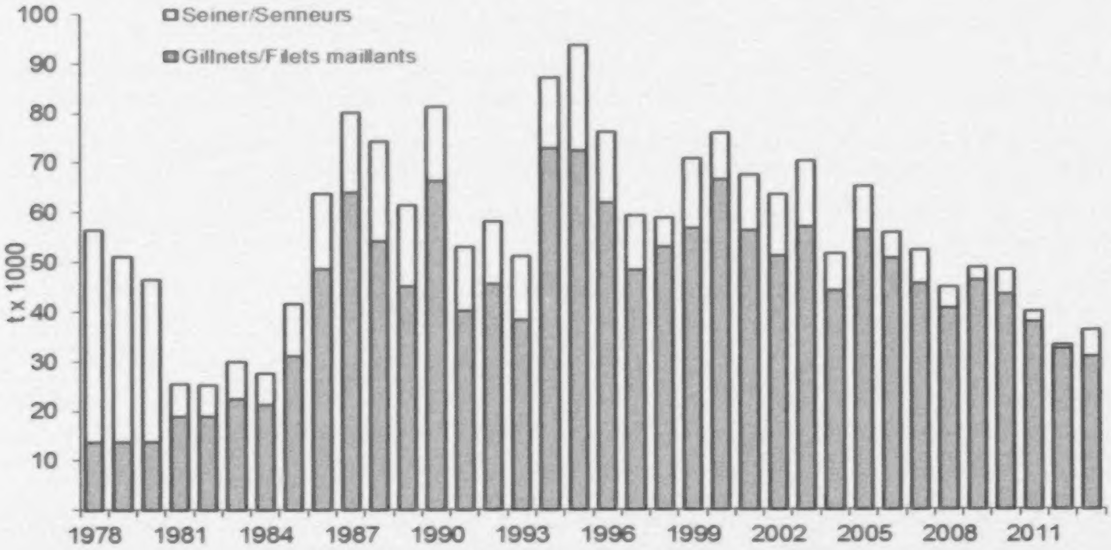
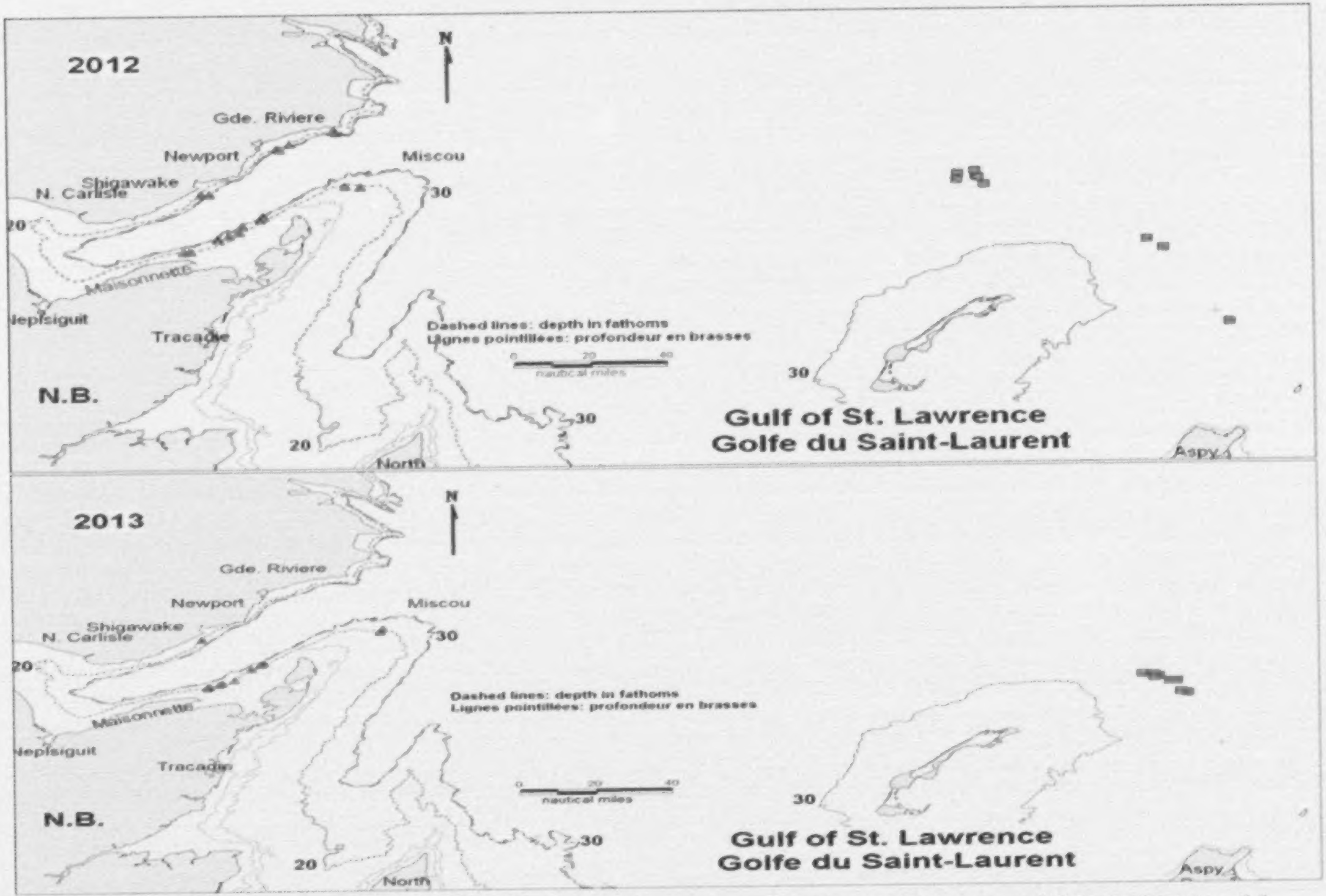


Figure 3. Spring and fall seasons combined 4T herring landings by fleet sector, 1978 to 2013.



2012
N
Gde. Riviere
Newport
Miscou
Shigawake
N. Carlisle
30
20
Maisonnette
Nepisiguit
Tracadie
Dashed lines: depth in fathoms
Lignes pointillées: profondeur en brasses
0
20
40
nautical miles
30
N.B.
30
Gulf of St. Lawrence
Golfe du Saint-Laurent
20
North
Aspy
2013
N
Gde. Riviere
Newport
Miscou
Shigawake
N. Carlisle
30
20
Maisonnette
Nepisiguit
Tracadie
Dashed lines: depth in fathoms
Lignes pointillées: profondeur en brasses
0
20
40
nautical miles
30
N.B.
30
Gulf of St. Lawrence
Golfe du Saint-Laurent
20
North
Aspy

Figure 4. Location of sets by large seiners under quota monitoring in the 2012 (upper panel) and 2013 (lower panel) fisheries (triangles = fall, rectangles = spring).

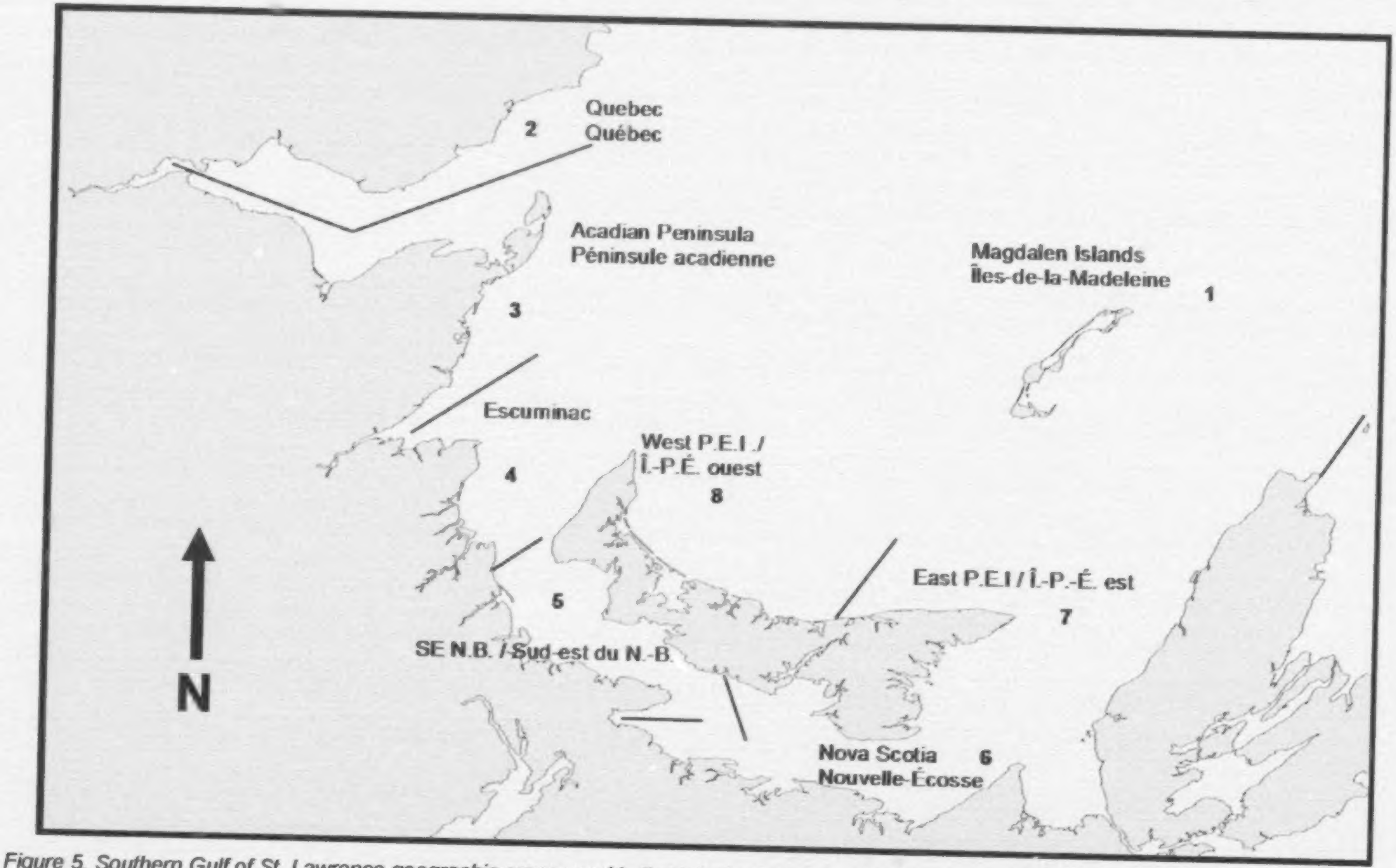

Quebec
Québec
2
Acadian Peninsula
Péninsule acadienne
3
Magdalen Islands
Îles-de-la-Madeleine
1
Escuminac
4
West P.E.I. /
Î.-P.É. ouest
8
East P.E.I / Î.-P.-É. est
7
5
SE N.B. / Sud-est du N.-B.
Nova Scotia
Nouvelle-Écosse
6
N

Figure 5. Southern Gulf of St. Lawrence geographic areas used in the telephone survey of the herring gillnet fishery.

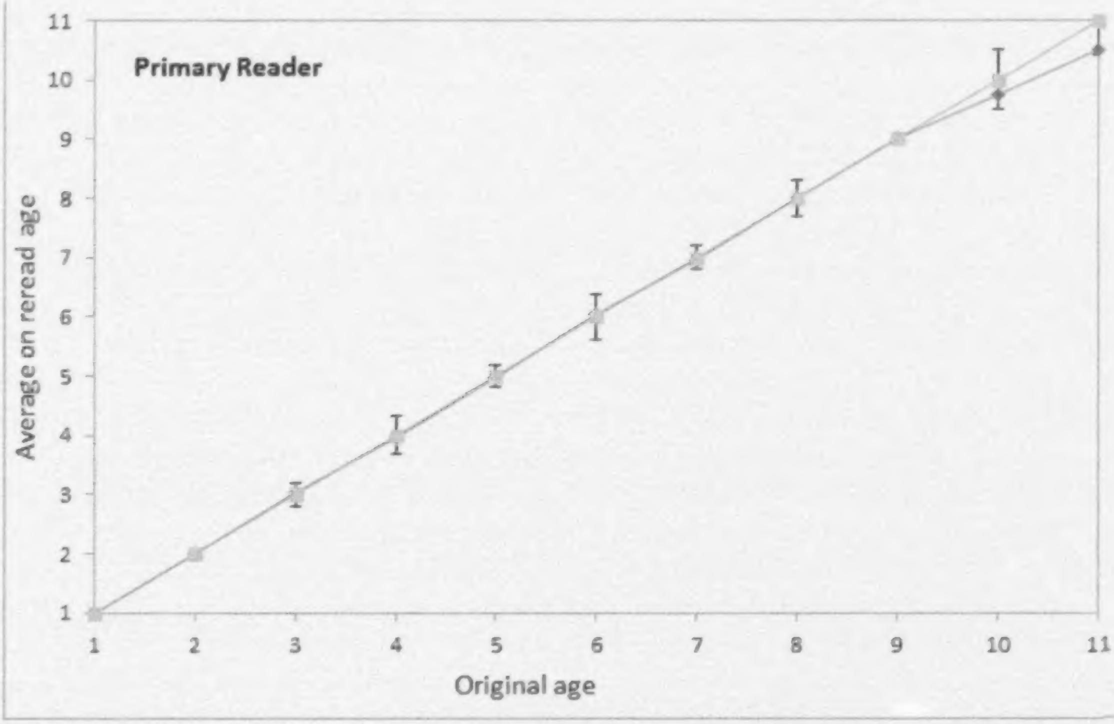


Figure 6. Comparison of ages obtained during the validation test with the original ages assigned. Bars indicate 95% confidence intervals. Squares are original ages, diamond-shapes average on reread ages.

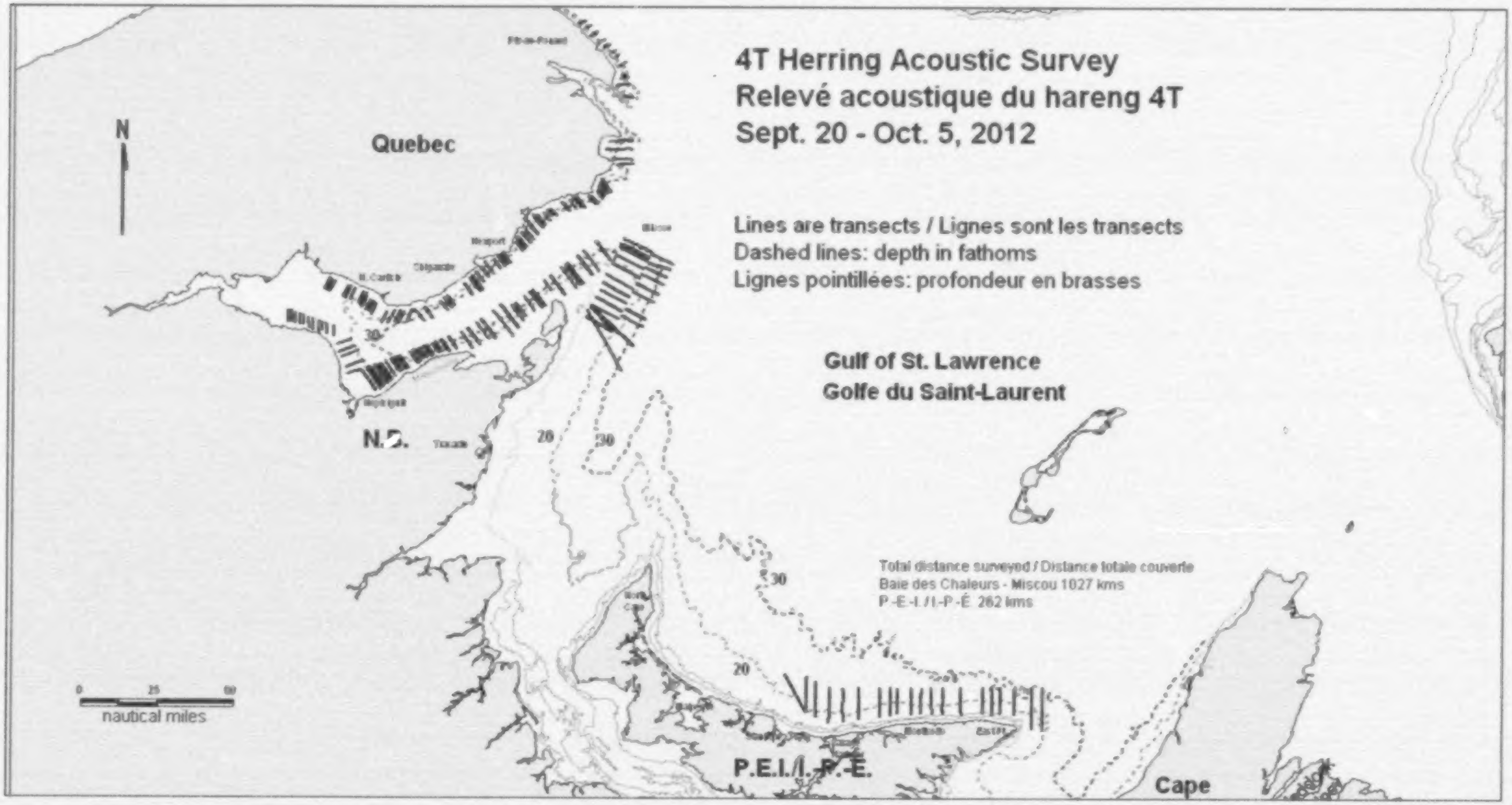

4T Herring Acoustic Survey
Relevé acoustique du hareng 4T
Sept. 20 - Oct. 5, 2012
Lines are transects / Lignes sont les transects
Dashed lines: depth in fathoms
Lignes pointillées: profondeur en brasses
N
Quebec
Gulf of St. Lawrence
Golfe du Saint-Laurent
N.B.
30
20
30
30
20
Total distance surveyed / Distance totale couverte
Baie des Chaleurs - Miscou 1027 kms
P.-E.-I. / I.-P.-É. 262 kms
0
25
50
nautical miles
P.E.I./Î.-P.-É.
Cape

Figure 7a. Surveyed transects covered during the 2012 acoustic survey (lines).

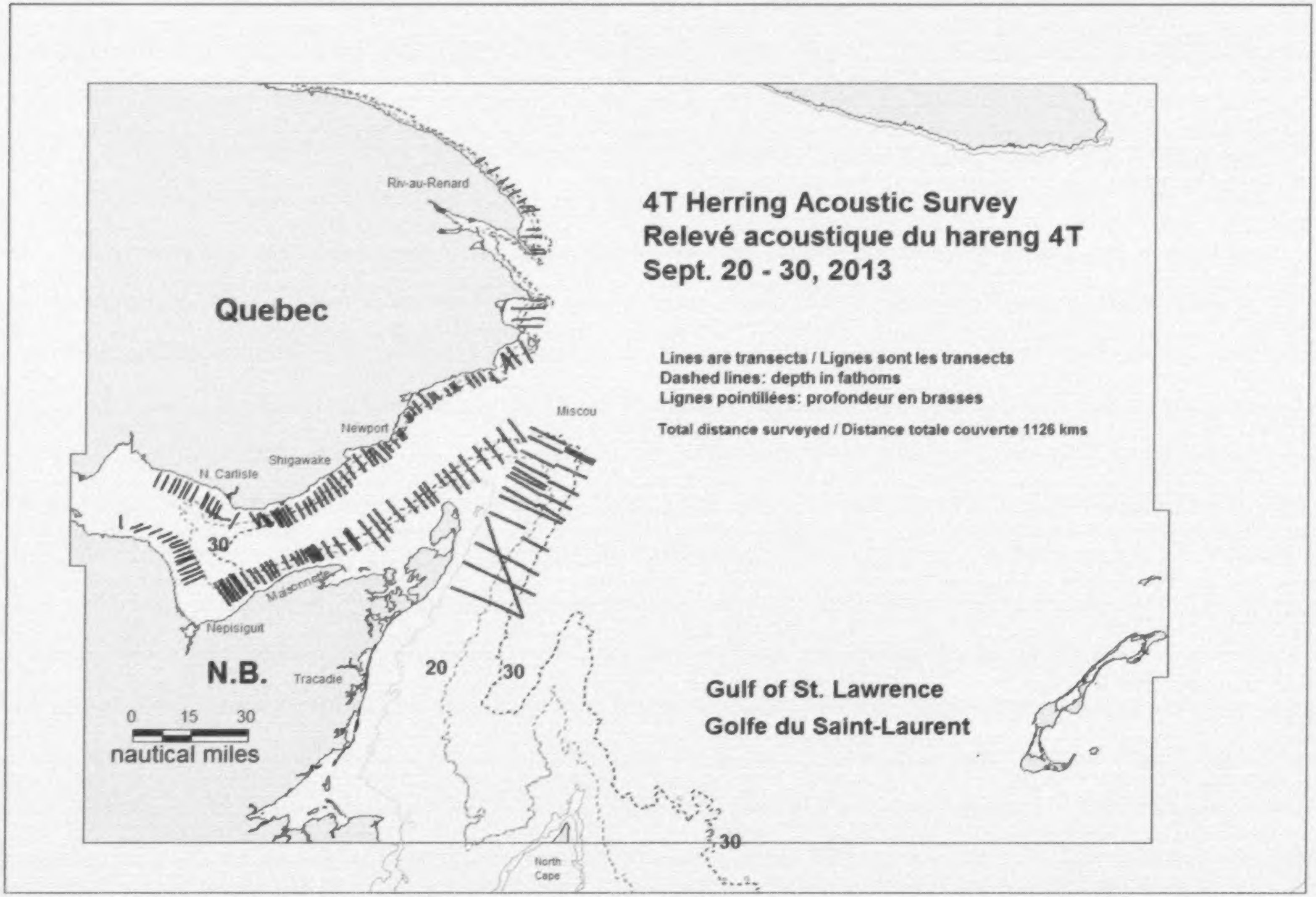

4T Herring Acoustic Survey
Relevé acoustique du hareng 4T
Sept. 20 - 30, 2013
Lines are transects / Lignes sont les transects
Dashed lines: depth in fathoms
Lignes pointillées: profondeur en brasses
Total distance surveyed / Distance totale couverte 1126 kms
Riv-au-Renard
Quebec
Miscou
Newport
Shigawake
N. Carlisle
30
Maisonnette
Nepisiguit
N.B.
Tracadie
20
30
0
15
30
nautical miles
Gulf of St. Lawrence
Golfe du Saint-Laurent
30
North Cape

Figure 7b. Surveyed transects covered during the 2013 acoustic survey (lines).

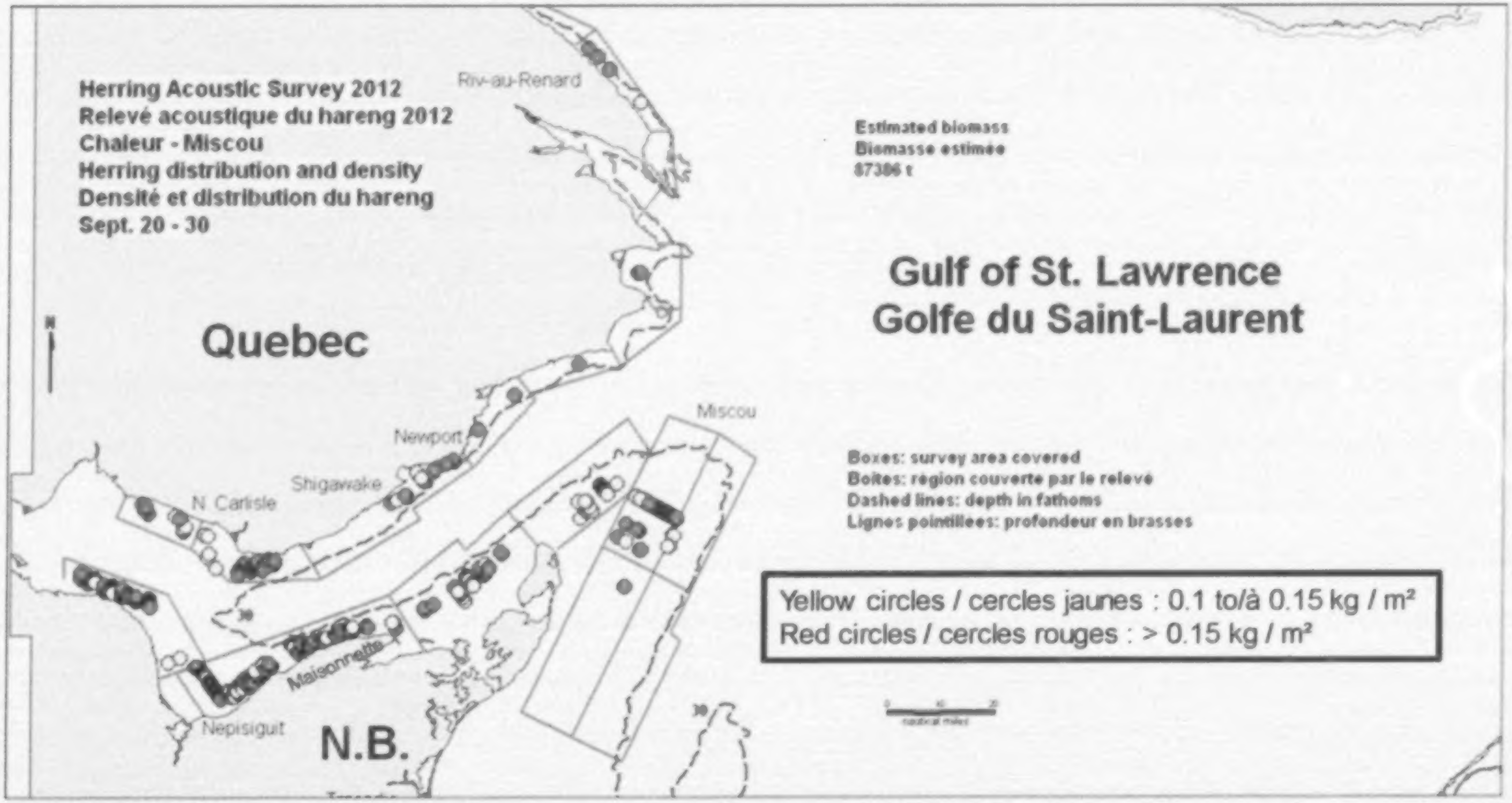

Herring Acoustic Survey 2012
Relevé acoustique du hareng 2012
Chaleur - Miscou
Herring distribution and density
Densité et distribution du hareng
Sept. 20 - 30
Riv-au-Renard
Estimated biomass
Biomasse estimée
87386 t
Gulf of St. Lawrence
Golfe du Saint-Laurent
Quebec
N
Newport
Shigawake
N. Carlisle
Miscou
Boxes: survey area covered
Boites: région couverte par le relevé
Dashed lines: depth in fathoms
Lignes pointillees: profondeur en brasses
Yellow circles / cercles jaunes : 0.1 to/à 0.15 kg / m²
Red circles / cercles rouges : > 0.15 kg / m²
30
Maisonnette
Nepisiguit
N.B.
nautical miles

Figure 8a. 2012 Acoustic survey relative biomass ranges detected in the Chaleurs-Miscou area (circles).

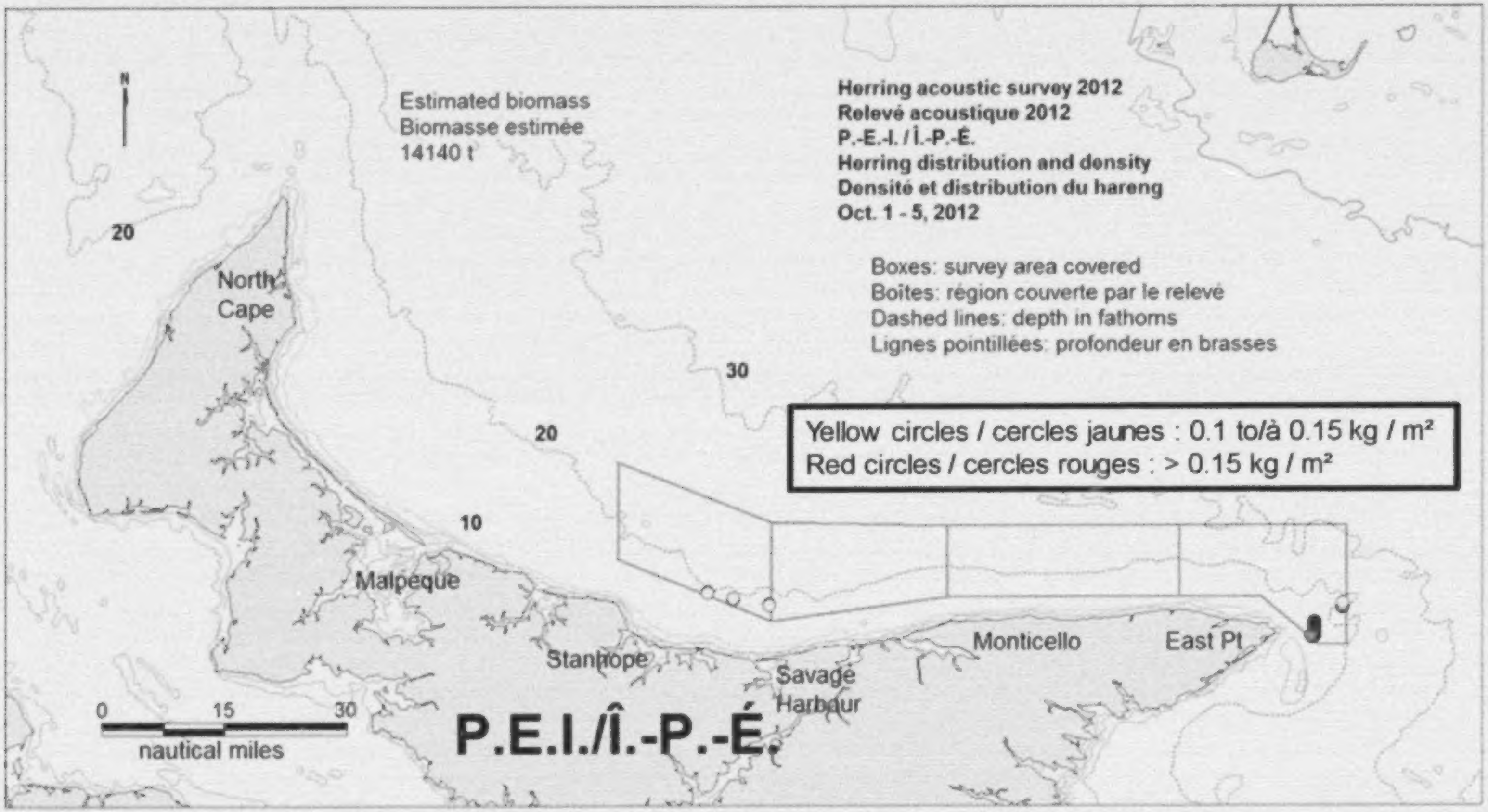

Estimated biomass
Biomasse estimée
14140 t
Herring acoustic survey 2012
Relevé acoustique 2012
P.-E.-I. / Î.-P.-É.
Herring distribution and density
Densité et distribution du hareng
Oct. 1 - 5, 2012
Boxes: survey area covered
Boîtes: région couverte par le relevé
Dashed lines: depth in fathoms
Lignes pointillées: profondeur en brasses
Yellow circles / cercles jaunes : 0.1 to/à 0.15 kg / m²
Red circles / cercles rouges : > 0.15 kg / m²
N
20
30
20
10
North Cape
Malpeque
Stanhope
Savage Harbour
Monticello
East Pt
0
15
30
nautical miles
P.E.I./Î.-P.-É.

Figure 8b. 2012 Acoustic survey relative biomass ranges detected in north Prince Edward Island (circles).

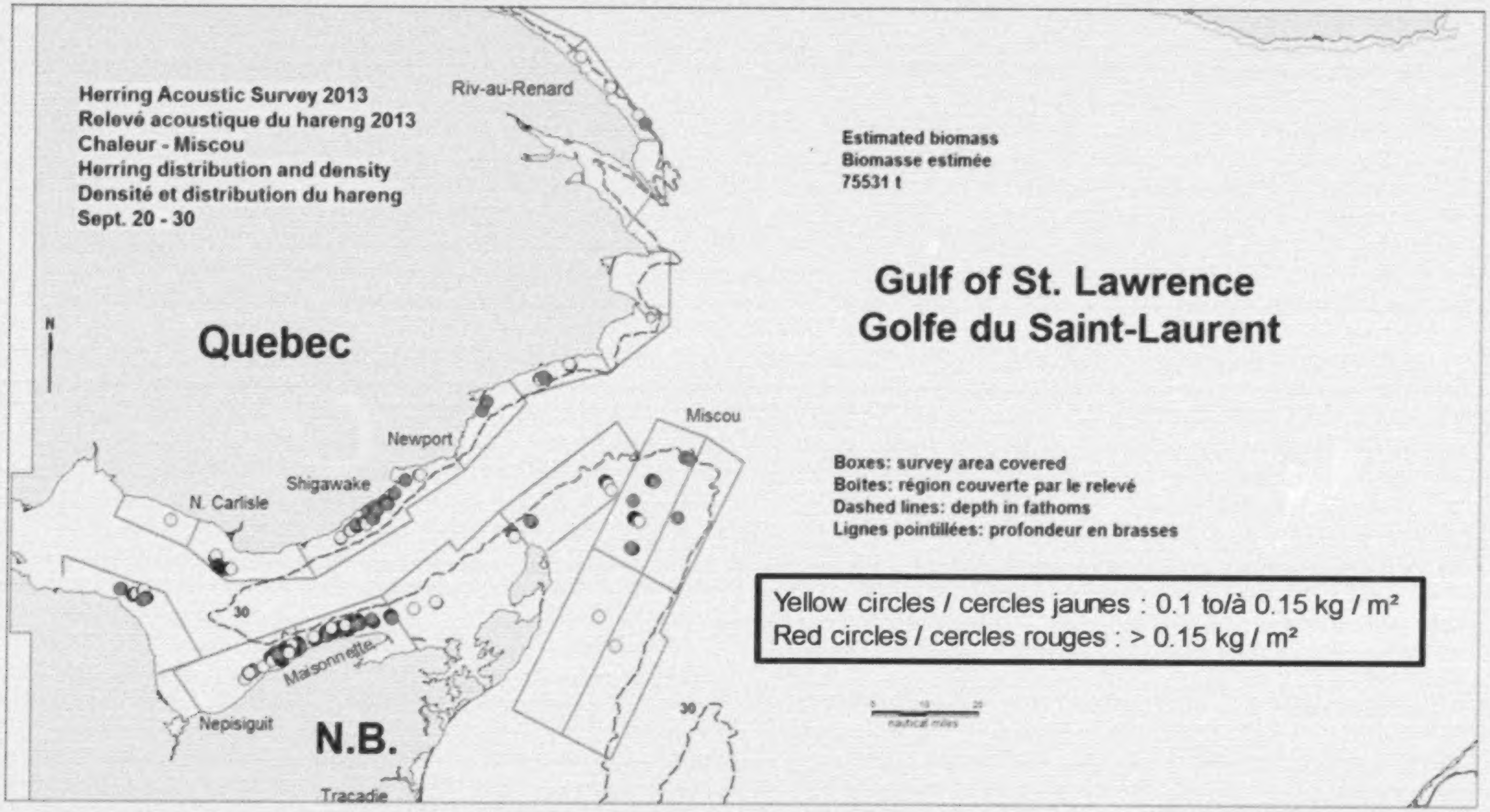

Herring Acoustic Survey 2013
Relevé acoustique du hareng 2013
Chaleur - Miscou
Herring distribution and density
Densité et distribution du hareng
Sept. 20 - 30
Riv-au-Renard
Estimated biomass
Biomasse estimée
75531 t
Gulf of St. Lawrence
Golfe du Saint-Laurent
N
Quebec
Miscou
Newport
Shigawake
N. Carlisle
Boxes: survey area covered
Boites: région couverte par le relevé
Dashed lines: depth in fathoms
Lignes pointillées: profondeur en brasses
Yellow circles / cercles jaunes : 0.1 to/à 0.15 kg / m²
Red circles / cercles rouges : > 0.15 kg / m²
30
Maisonnette
30
0
10
20
nautical miles
Nepisiguit
N.B.
Tracadie

Figure 9. 2013 Acoustic survey relative biomass ranges detected in the Chaleurs-Miscou area (circles).

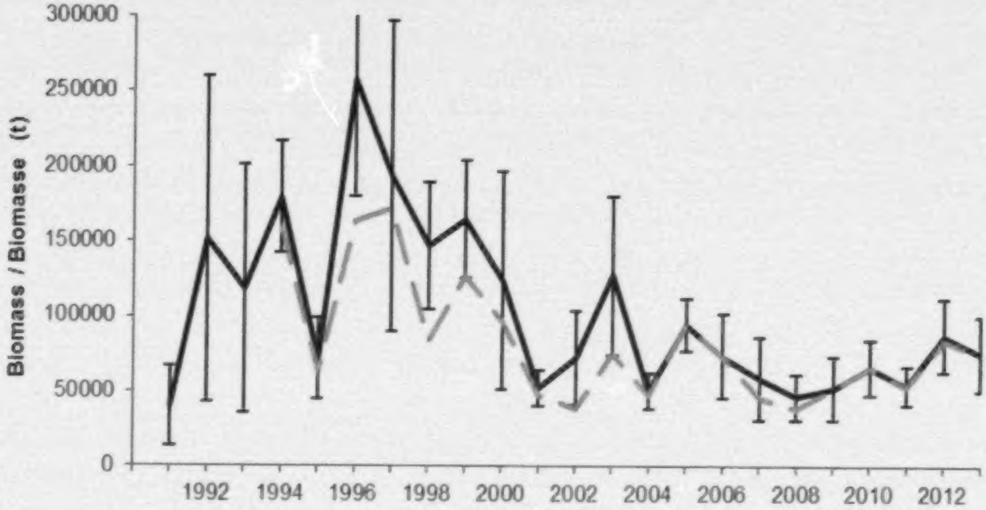


Figure 10. Acoustic survey biomass index, combined spring and fall spawners, of all strata from Chaleurs-Miscou (solid line) compared to Chaleurs-Miscou strata consistently surveyed in each year since 1994 (dotted line) (error bars ± 2 S.E.).

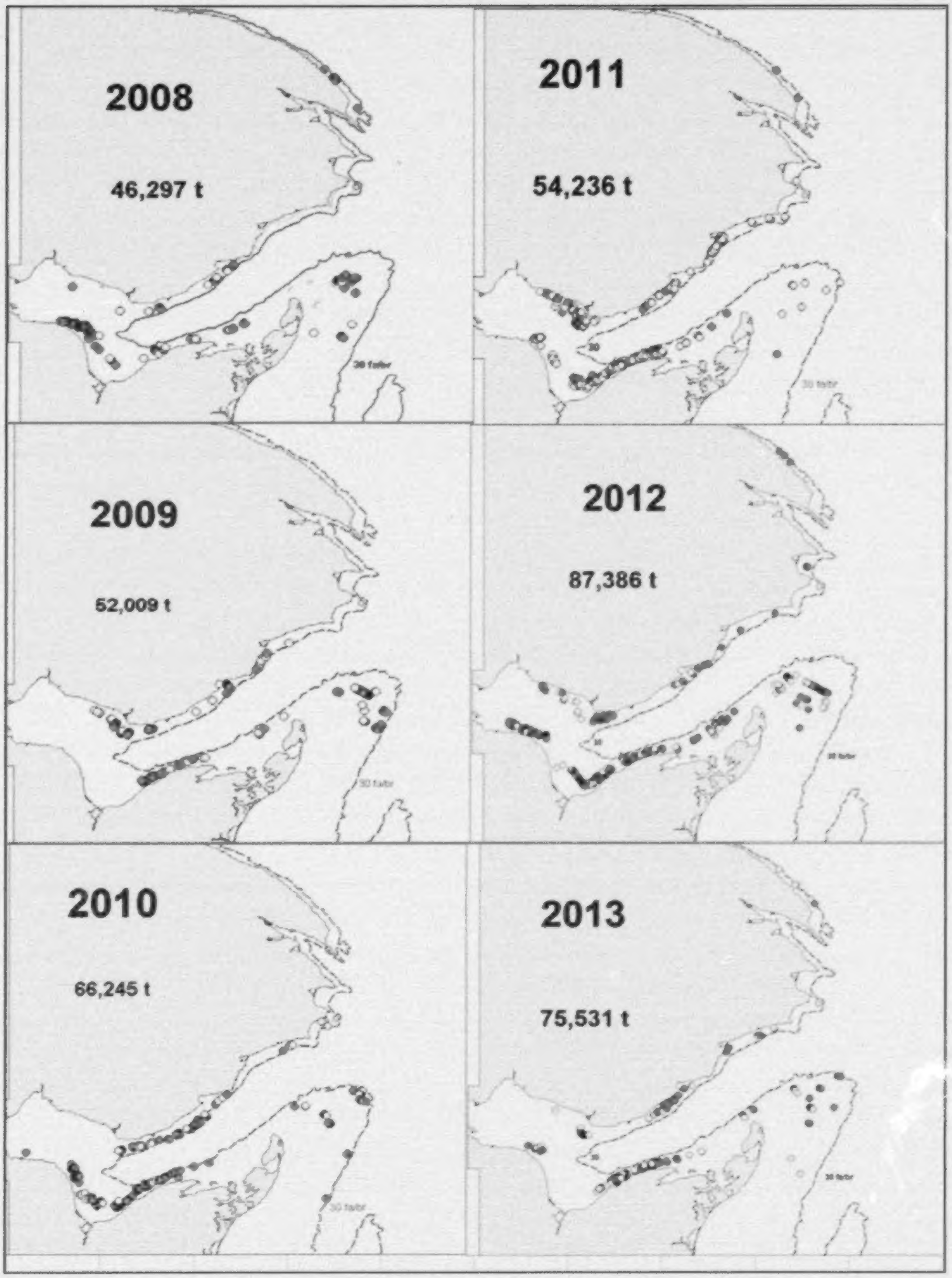

2008
46,297 t
30 fathr
2011
54,236 t
30 fathr
2009
52,009 t
30 fathr
2012
87,386 t
30 fathr
2010
66,245 t
30 fathr
2013
75,531 t
30 fathr

Figure 11. Acoustic survey Chaleurs-Miscou herring distribution, density and biomass estimates 2008-2013. Yellow circles represent 0 to 0.15 kg per m² ; red circles represent 0.15 to 10 kg per m².

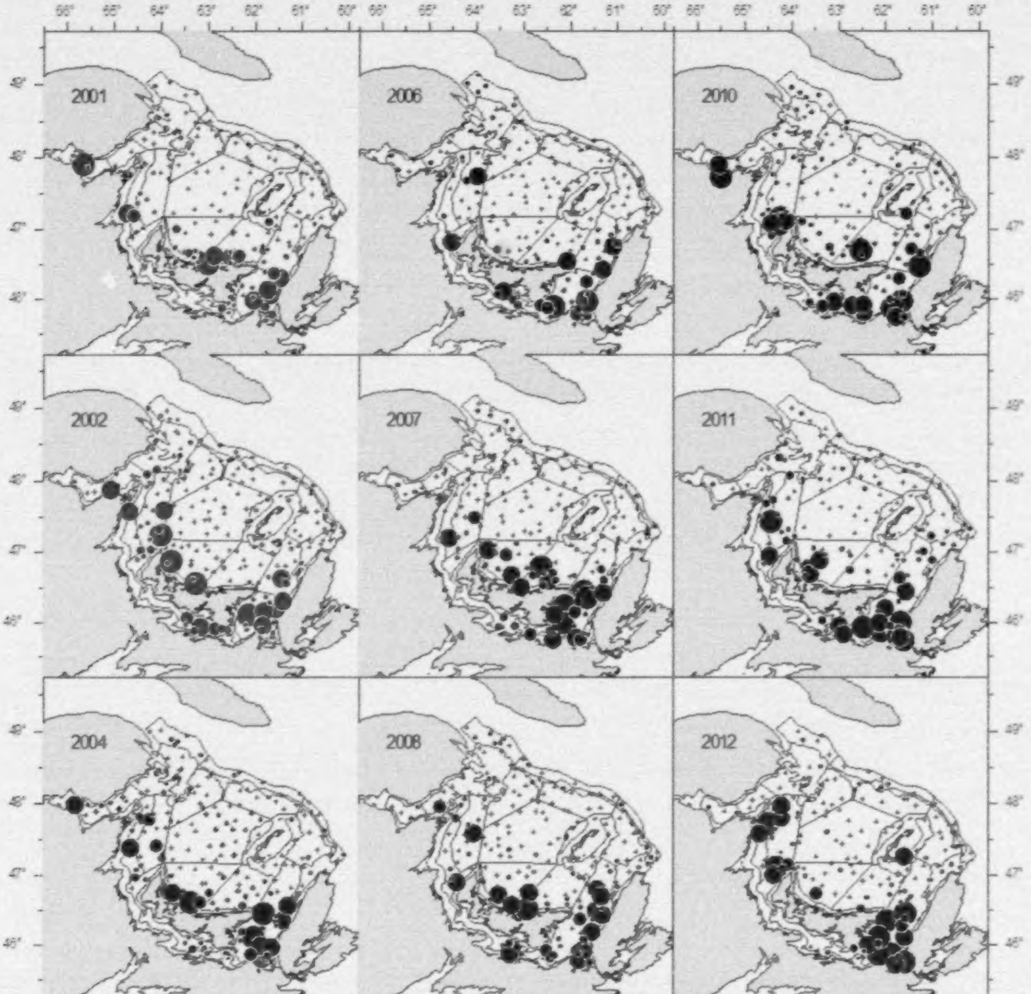

66°
65°
64°
63°
62°
61°
60°
49°
48°
47°
46°
2001
2006
2010
2002
2007
2011
2004
2008
2012
2005
2009
2013

Figure 12. Atlantic herring catches (kg/tow) in the southern Gulf of St. Lawrence September bottom-trawl surveys from 2001 to 2013, excluding 2003.

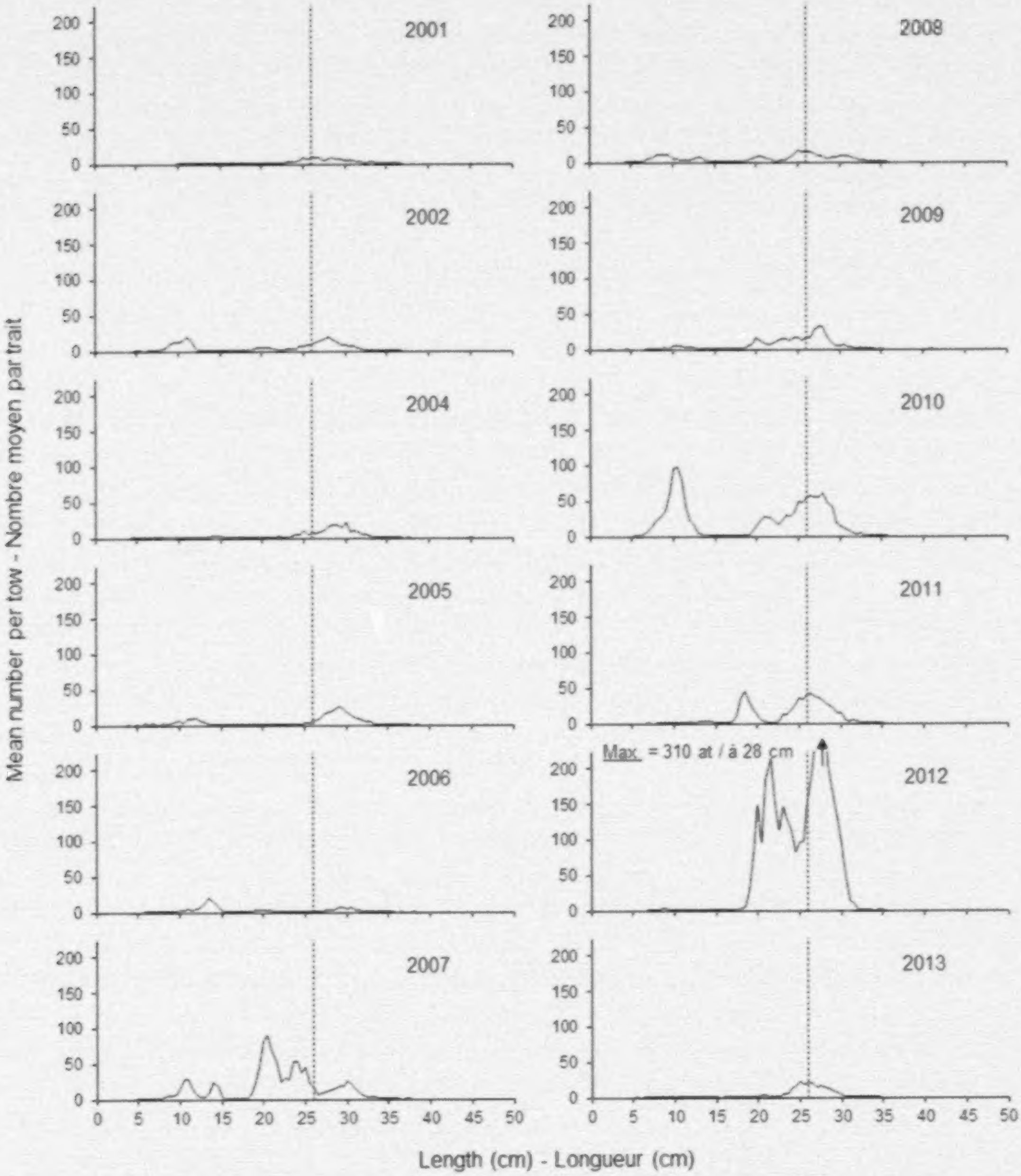


Figure 13. Length frequencies (mean number per tow) of Atlantic herring in the southern Gulf of St. Lawrence September bottom-trawl surveys in 4T from 2001-2013. The vertical line indicates the regulated minimum size in the fishery (26 cm total length).

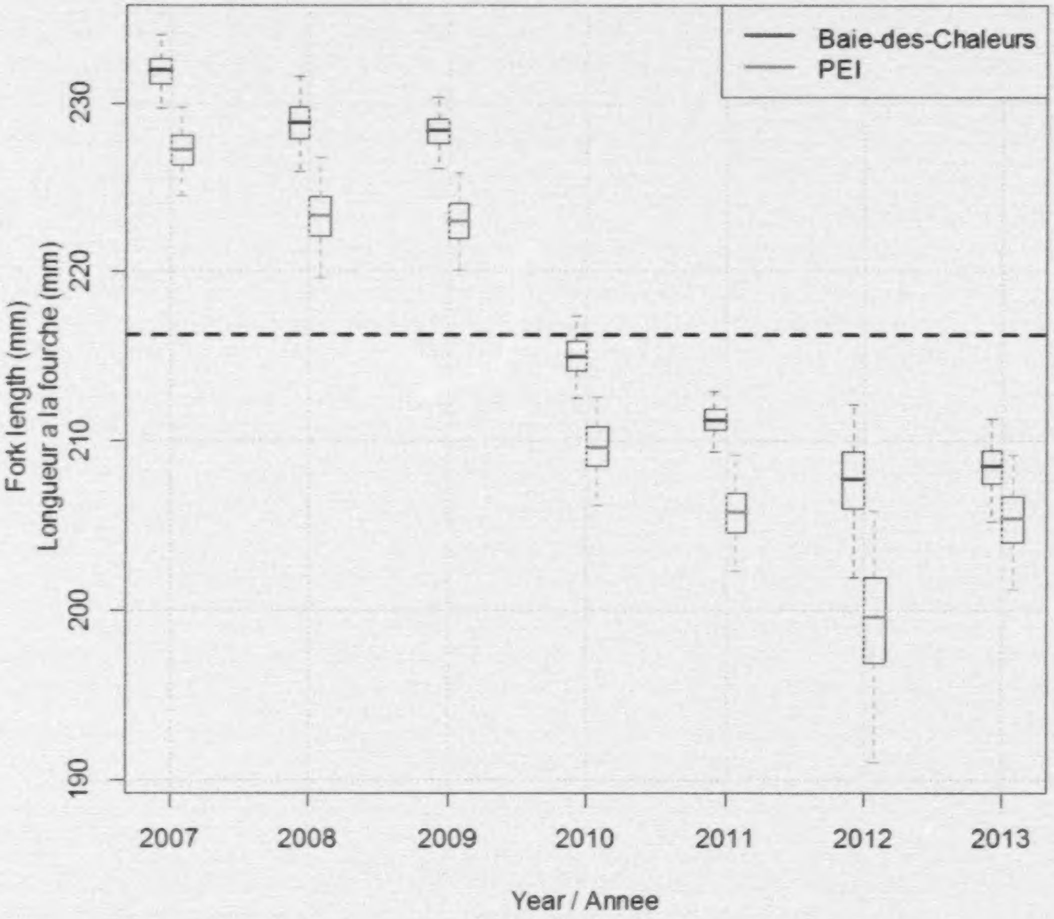


Figure 14. Box-plot of size-at-maturity estimates by year and survey area. Thick line indicates the median, the box the interquartile range and the whiskers the 95% confidence interval. Simulated values were obtained via bootstrap (n = 1000).The dotted line represents the 2007 to 2013 mean fork length at 50% maturity (L50).

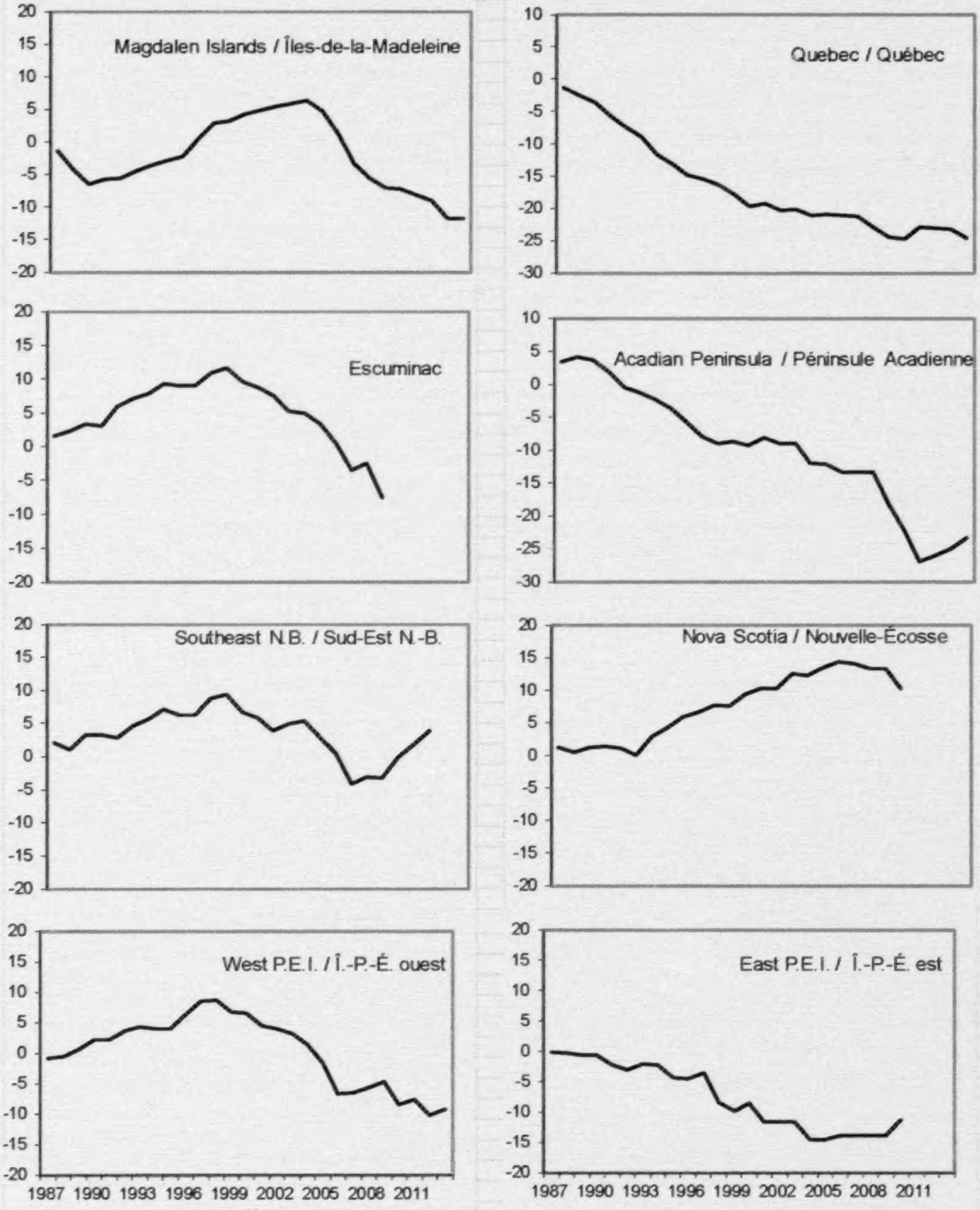


Figure 15. Cumulative indices of opinion on spring spawner abundance by area from the telephone survey.

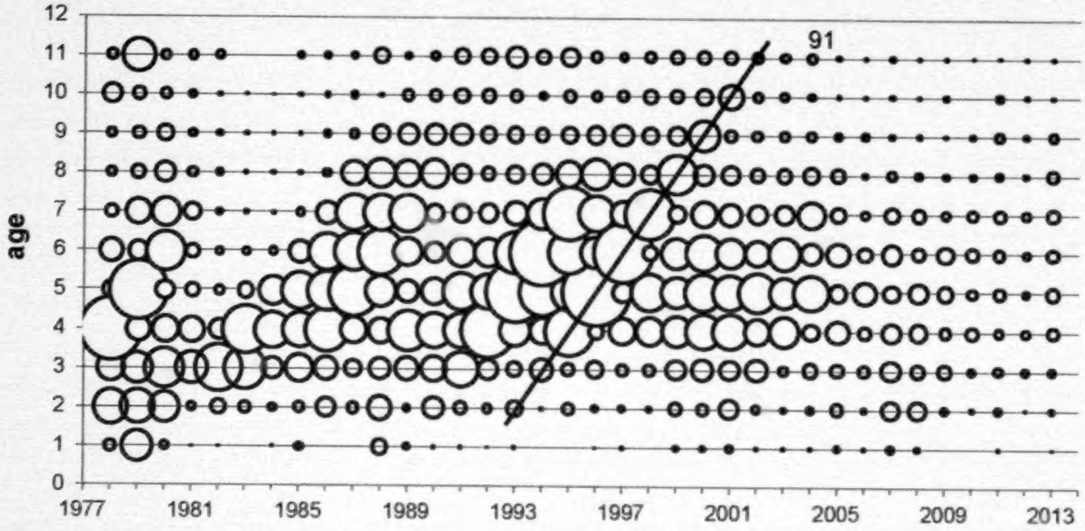


Figure 16. Catch-at-age of spring spawner component from the fishery, all gears combined. Bubbles represent numbers-at-age of total catch, line represents most recent strong year-class (1991).

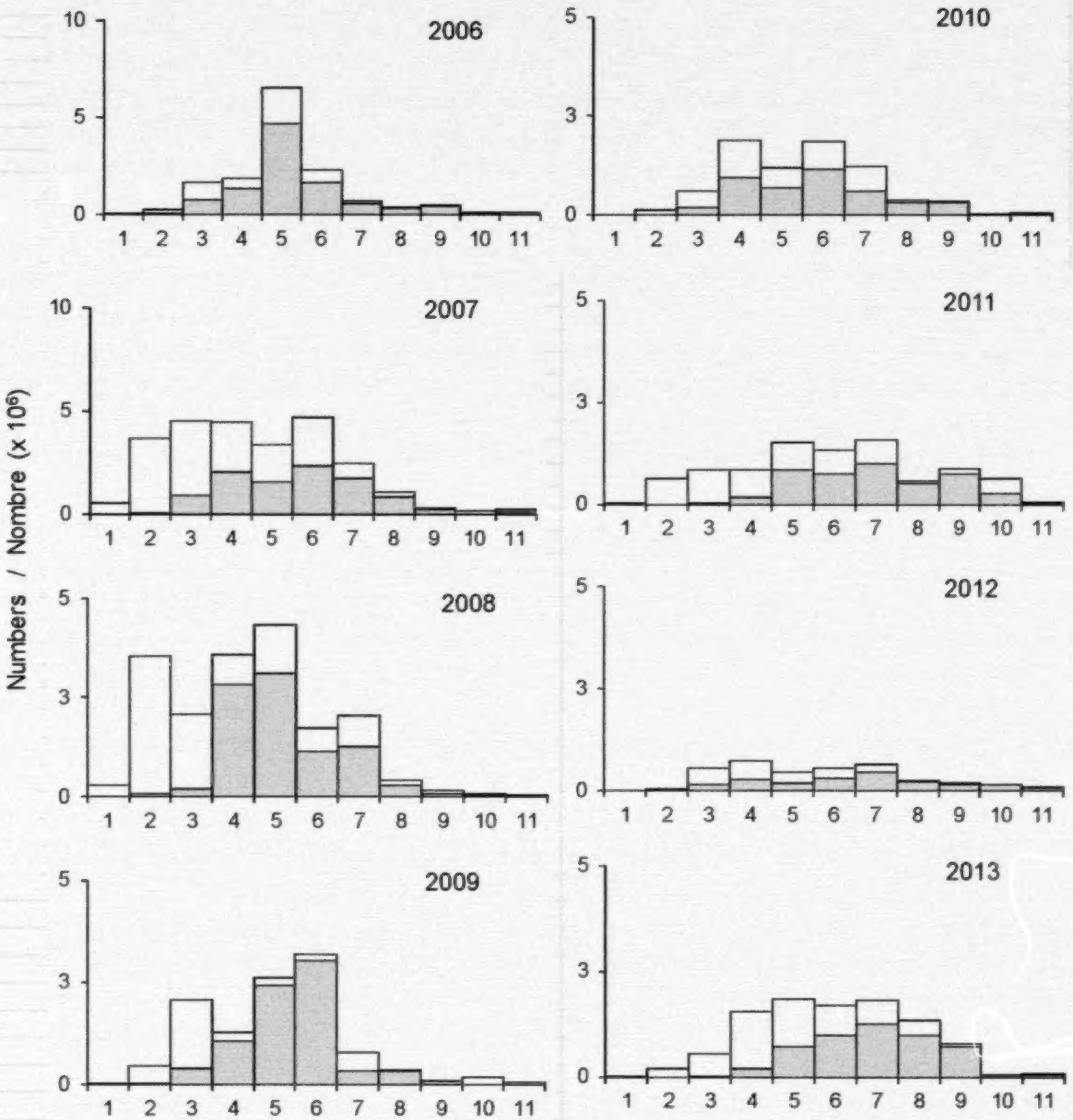


Figure 17. Catch-at-age (2004 to 2013) of spring spawner component from the fishery, all gears combined. The clear part of the bars is the mobile gear catches, and the grey part is the fixed gear catches.

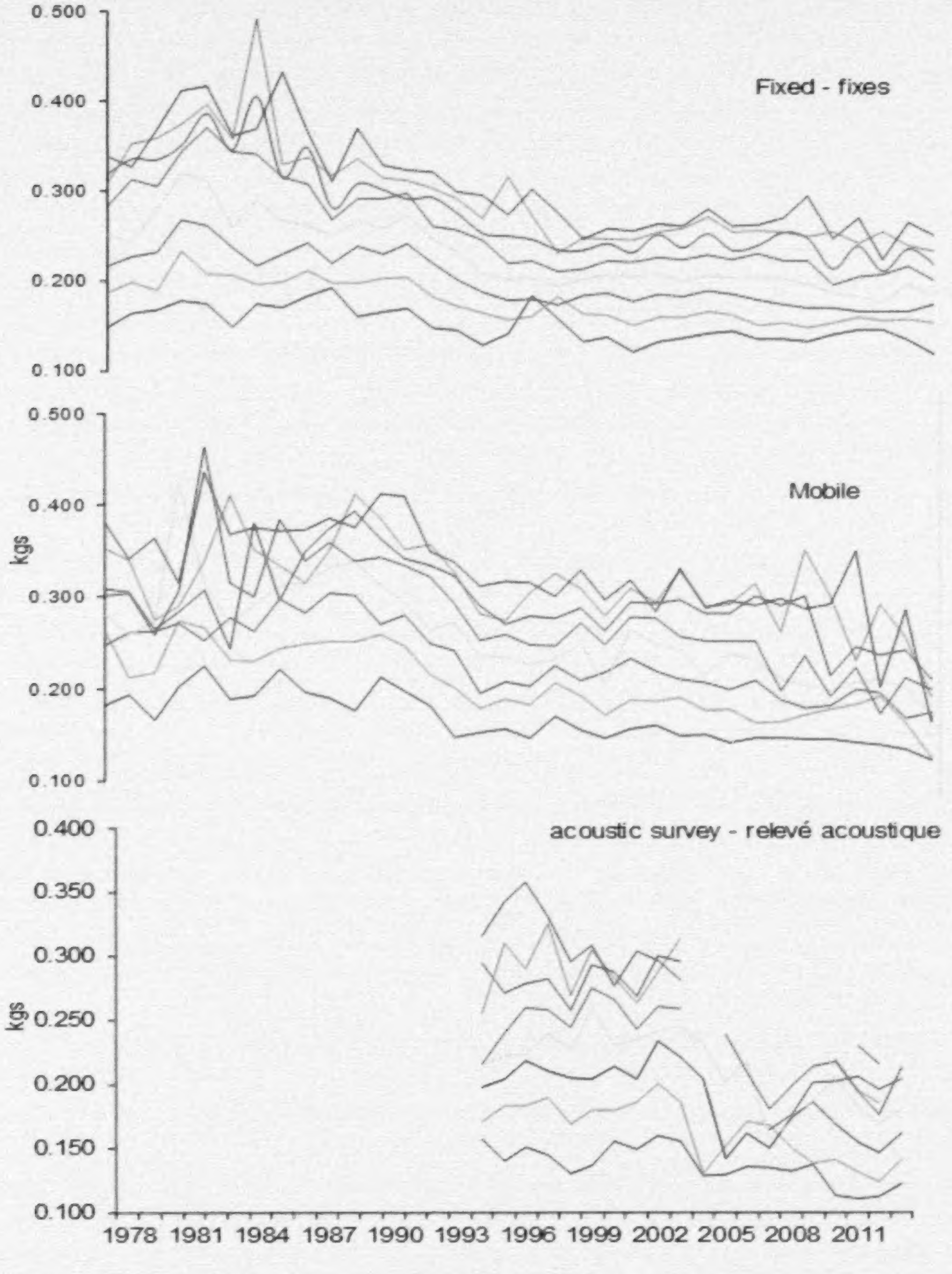


Figure 18. Mean weight-at-age of spring spawners for fixed and mobile commercial gears and the acoustic survey, ages 3 (bottom line) to 10 (top line).

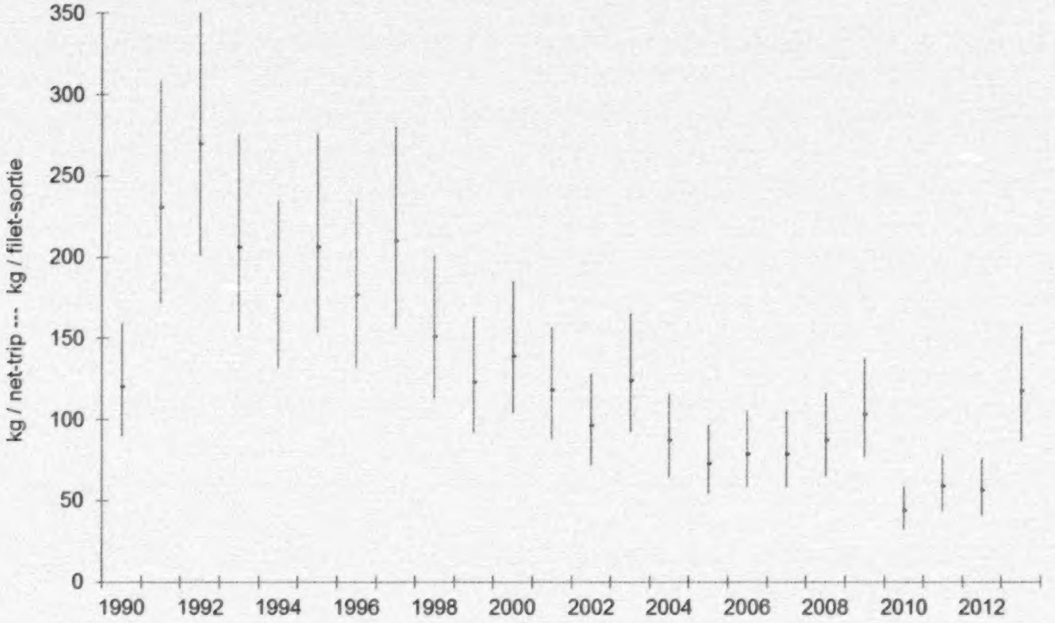


Figure 19. Gillnet catch rates (CPUE) of spring spawners from all areas with fishing activity reported through dockside monitoring in April and May (aggregated by day and area and weighted by the catch for that area). Error bars indicate approximate 95% confidence intervals.

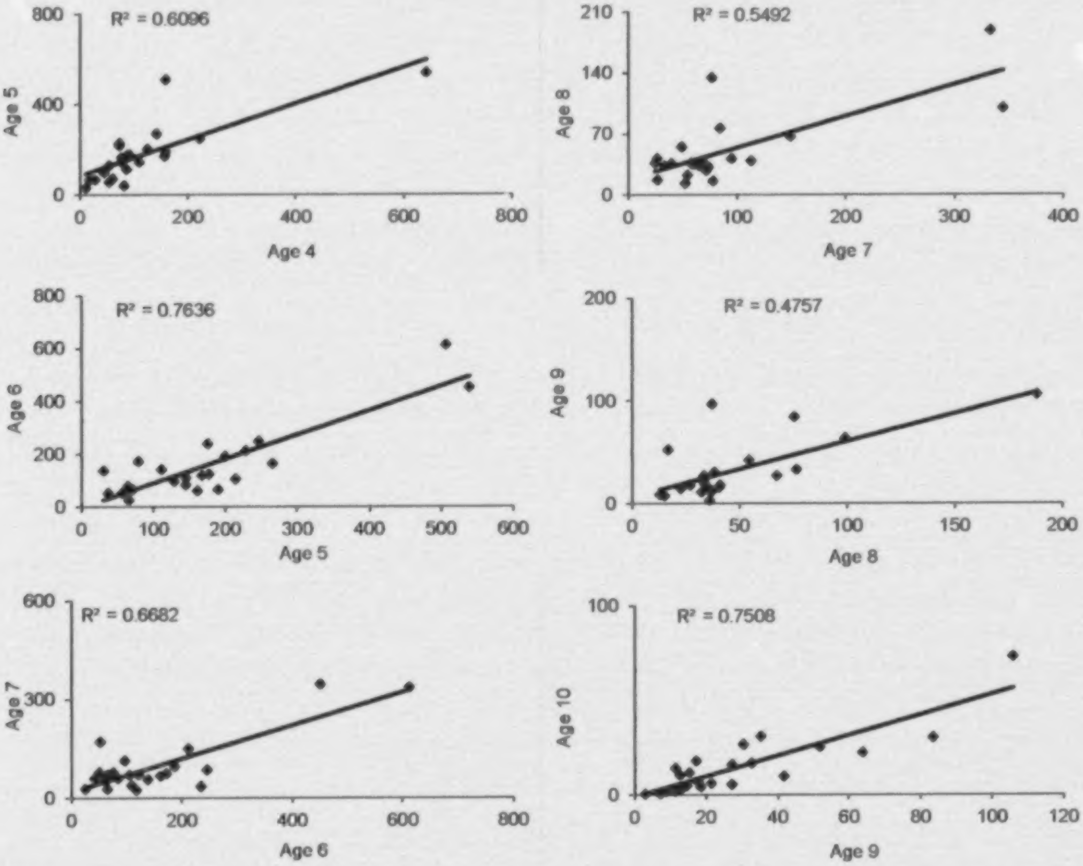


Figure 20. Regression of age-class abundance of spring spawners from one year to the next. The data are from gillnet catch rates CPUE as numbers of herring.

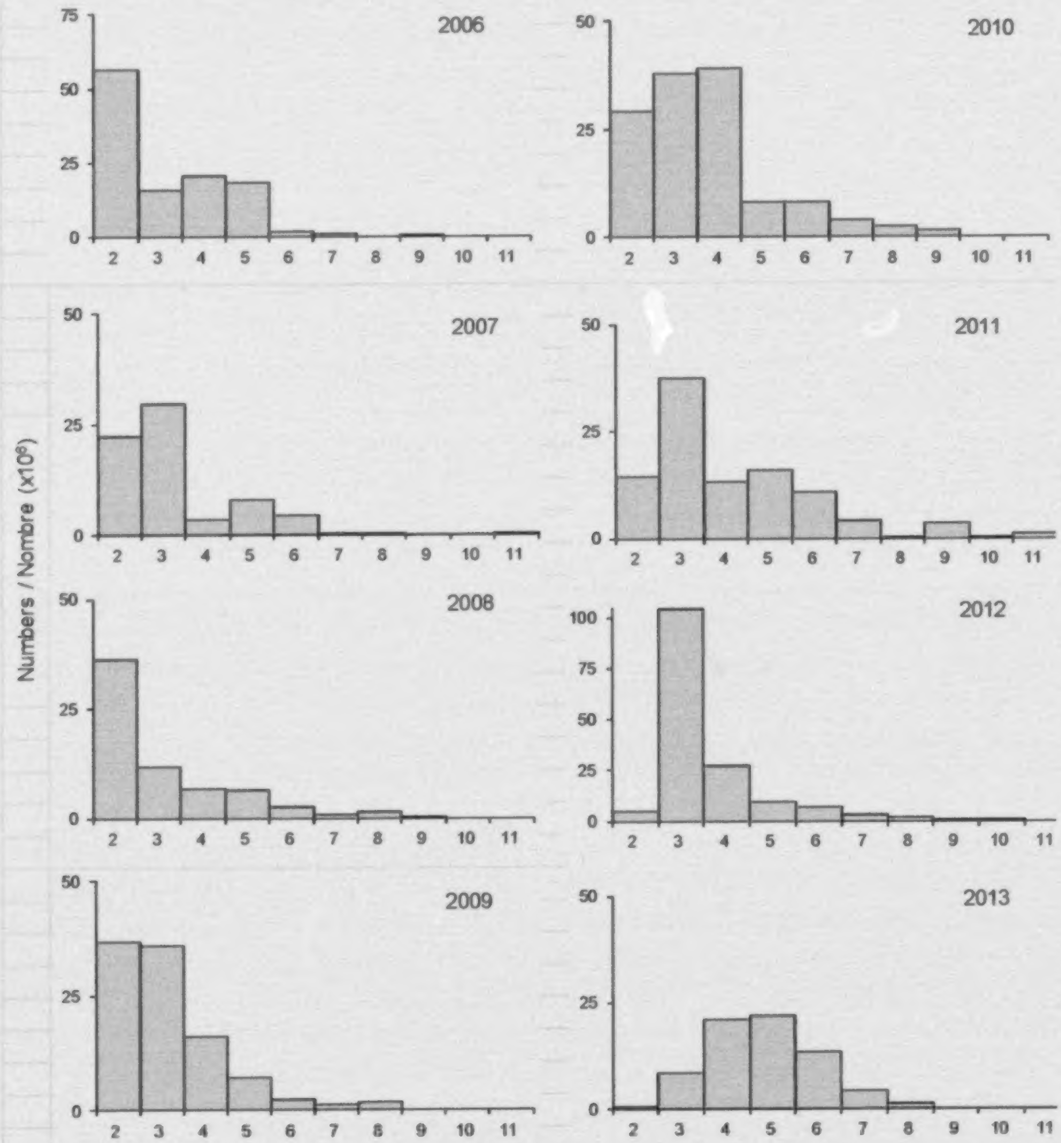


Figure 21. Numbers-at-age (2004 to 2013) of the spring spawner component for same strata covered in the Chaleurs-Miscou area during the acoustic survey.

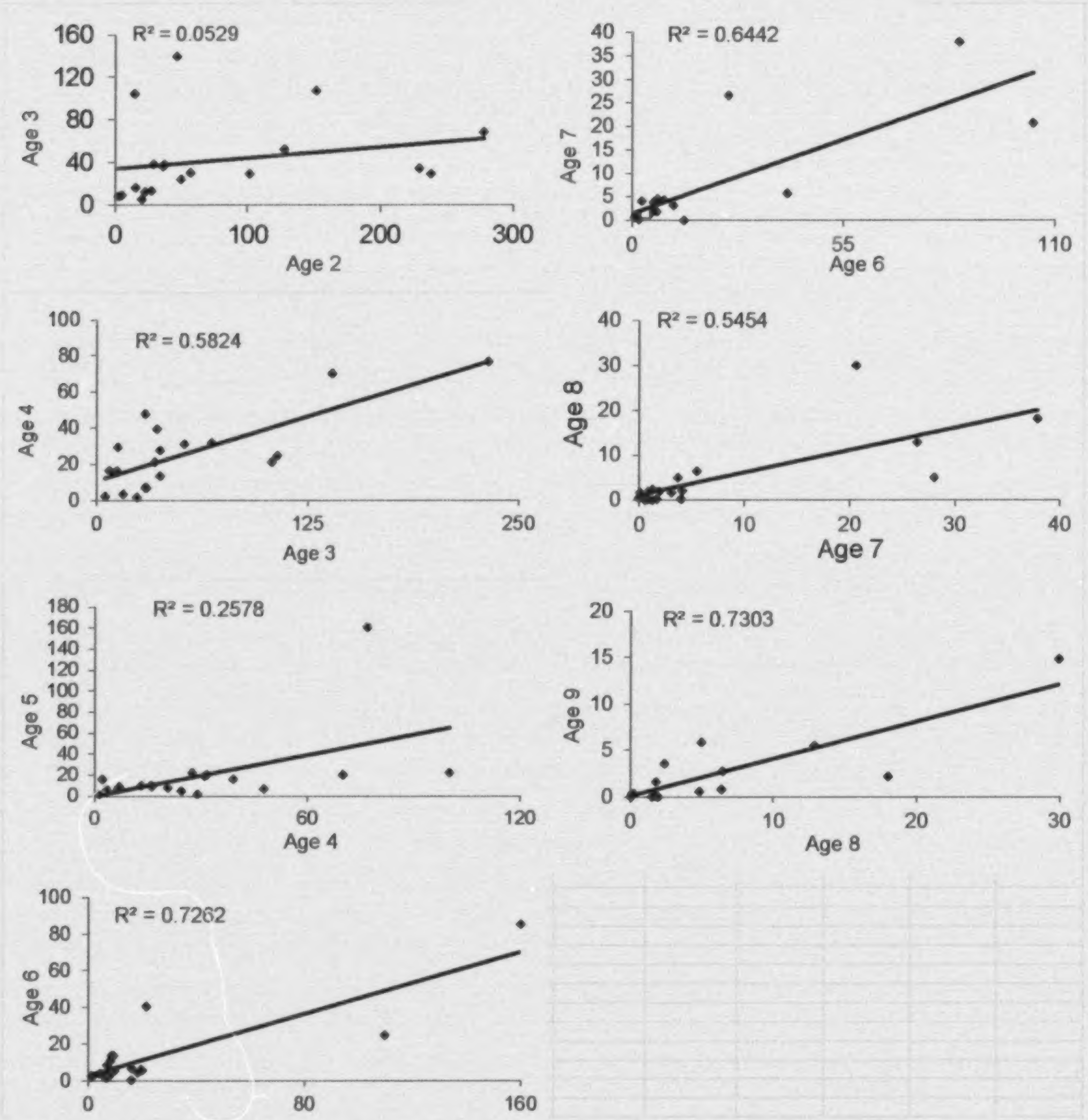


Figure 22. Spring spawner regression of age-class abundance (numbers x 105) from one year to the next. The data are from catch-at-age of the acoustic survey Chaleurs-Miscou same stratum surveyed from 1994 to 2013.

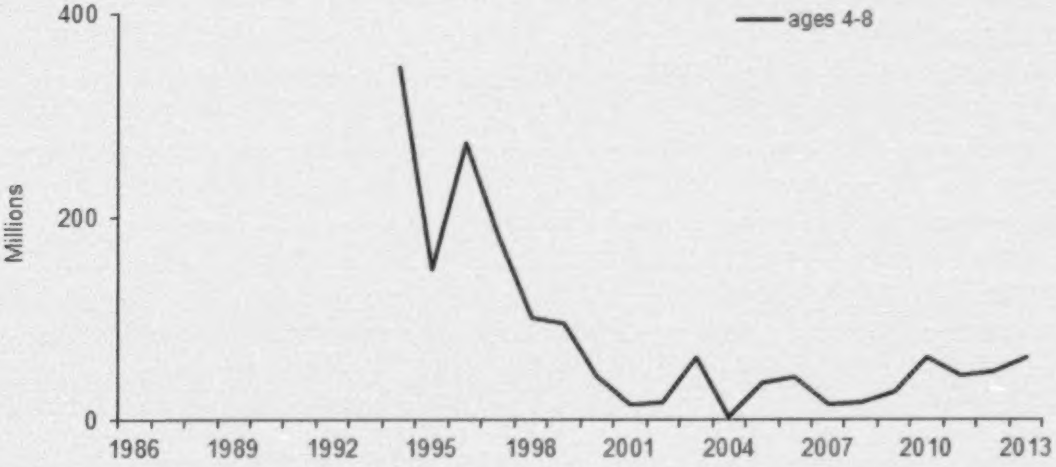


Figure 23. Acoustic survey index of spring spawner component from strata consistently surveyed in each year since 1994 (number in millions of fish).

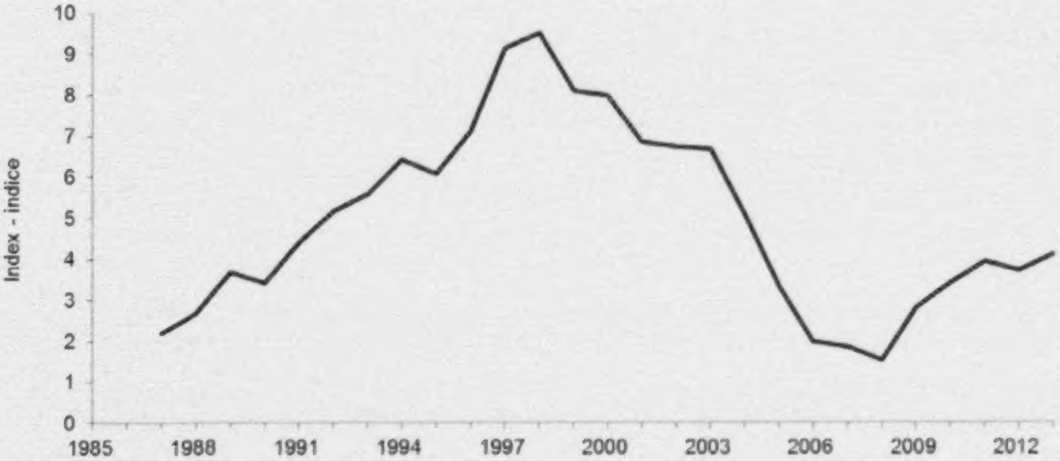


Figure 24. Spring index of opinion on abundance from the telephone survey for all areas combined, weighted by the catch in each area.

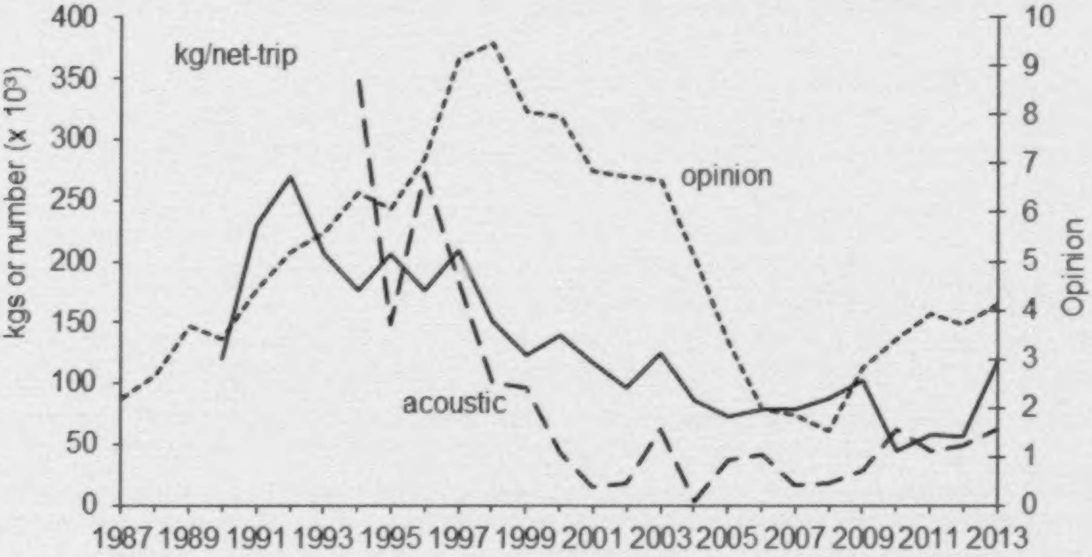


Figure 25. Gillnet catch rates (CPUE kg/net-trip), acoustic survey index (age 4-8 numbers), and telephone survey opinion index of the spring spawner component for 1987 to 2013.

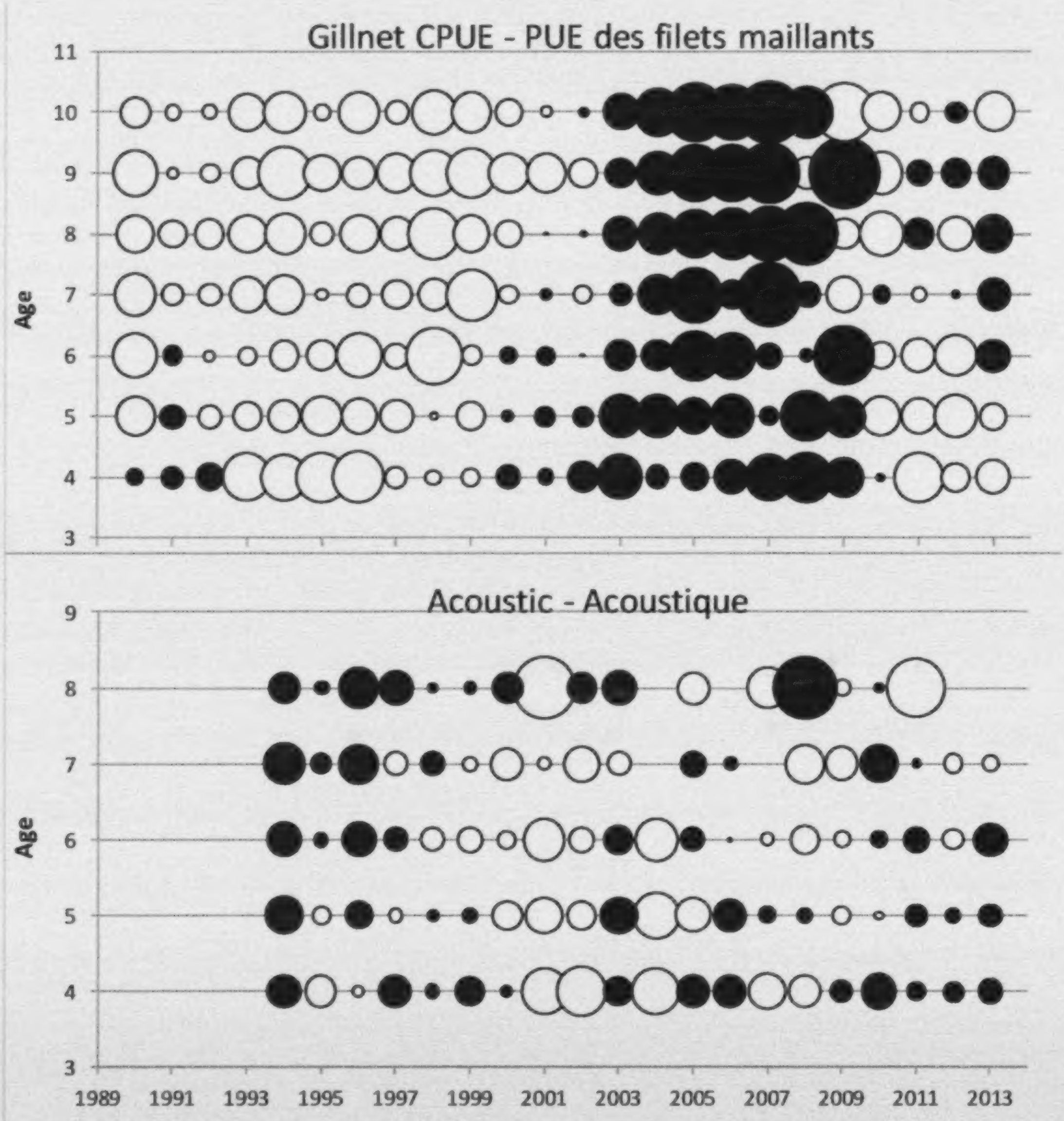


Figure 26. Residuals for the ADAPT calibration of the spring spawner SPA using the age disaggregated gillnet CPUE (upper panel) and acoustic survey (lower panel) indices. Circles indicate relative residual size (black is positive; white is negative).

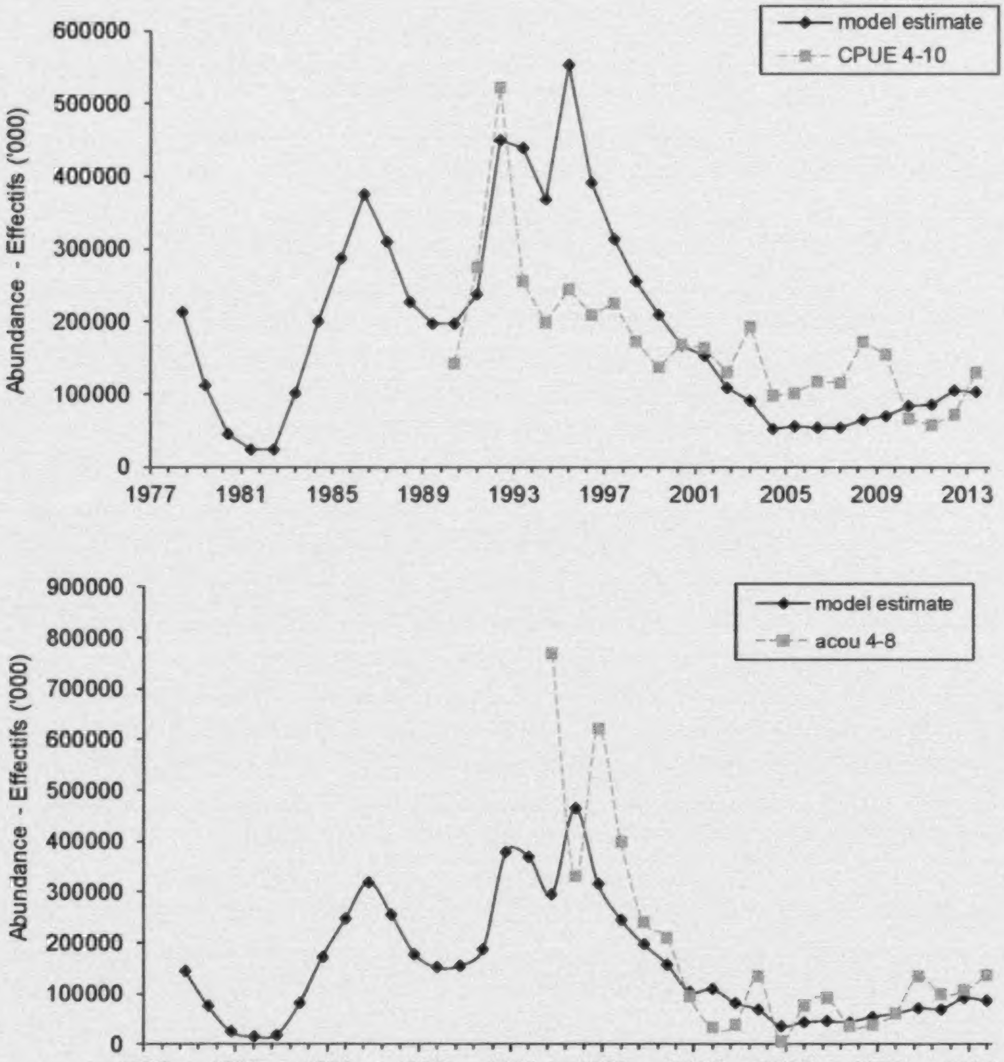


Figure 27. Comparison of CPUE (upper panel) and acoustic (lower panel) indices, corrected for catchability and the model estimates of population abundance for 4T spring spawner herring component, 1978 to 2014.

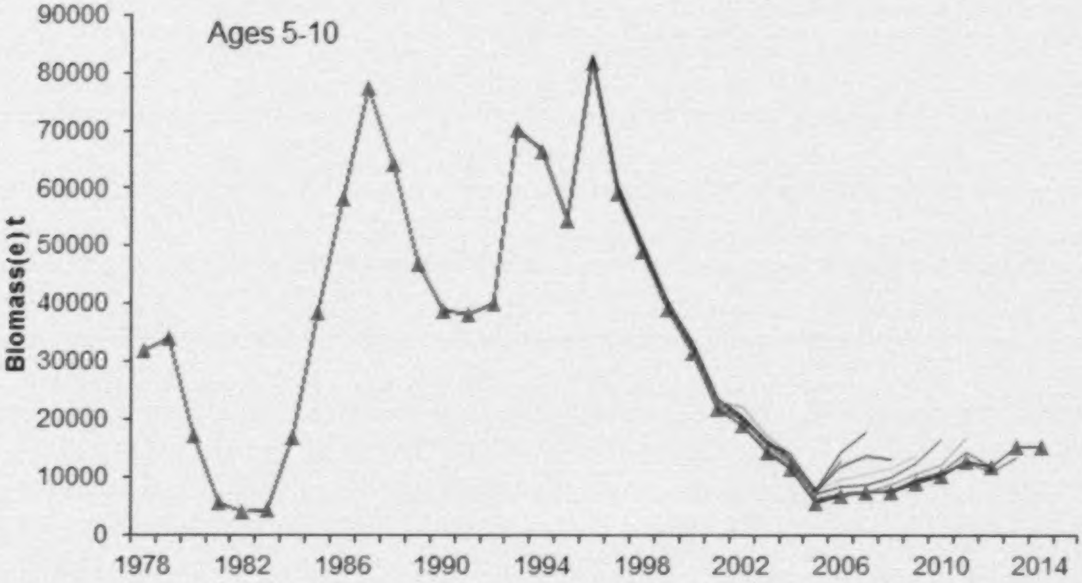


Figure 28. Retrospective patterns (ages 5 – 10) in the spring spawner ADAPT-SPA using the age-disaggregated gillnet CPUE and acoustic survey indices, 1978 to 2014.

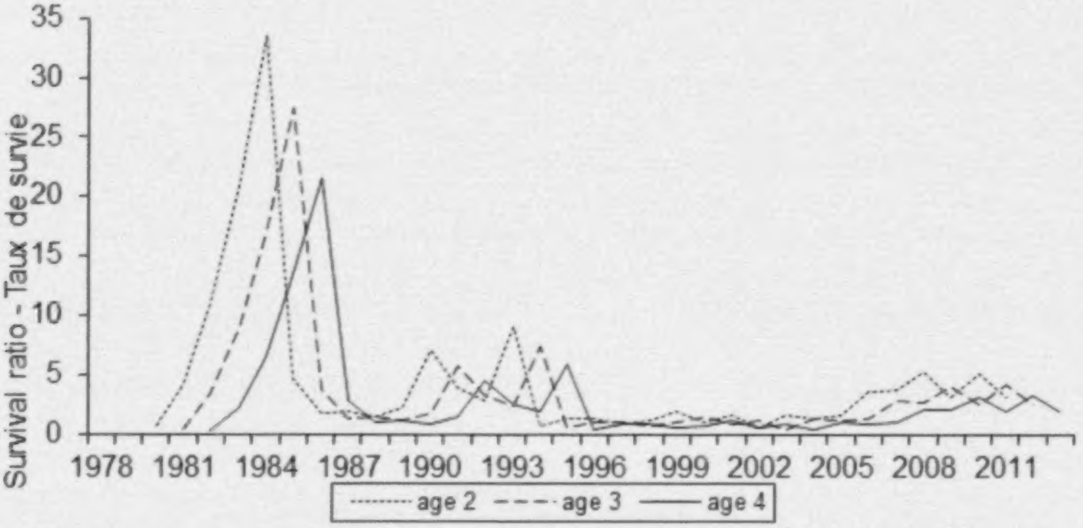


Figure 29. Survival ratio (age n abundance in year t / SSB in year t-n) for spring spawner recruits,aged 2 to 4 years, 1980 to 2013.

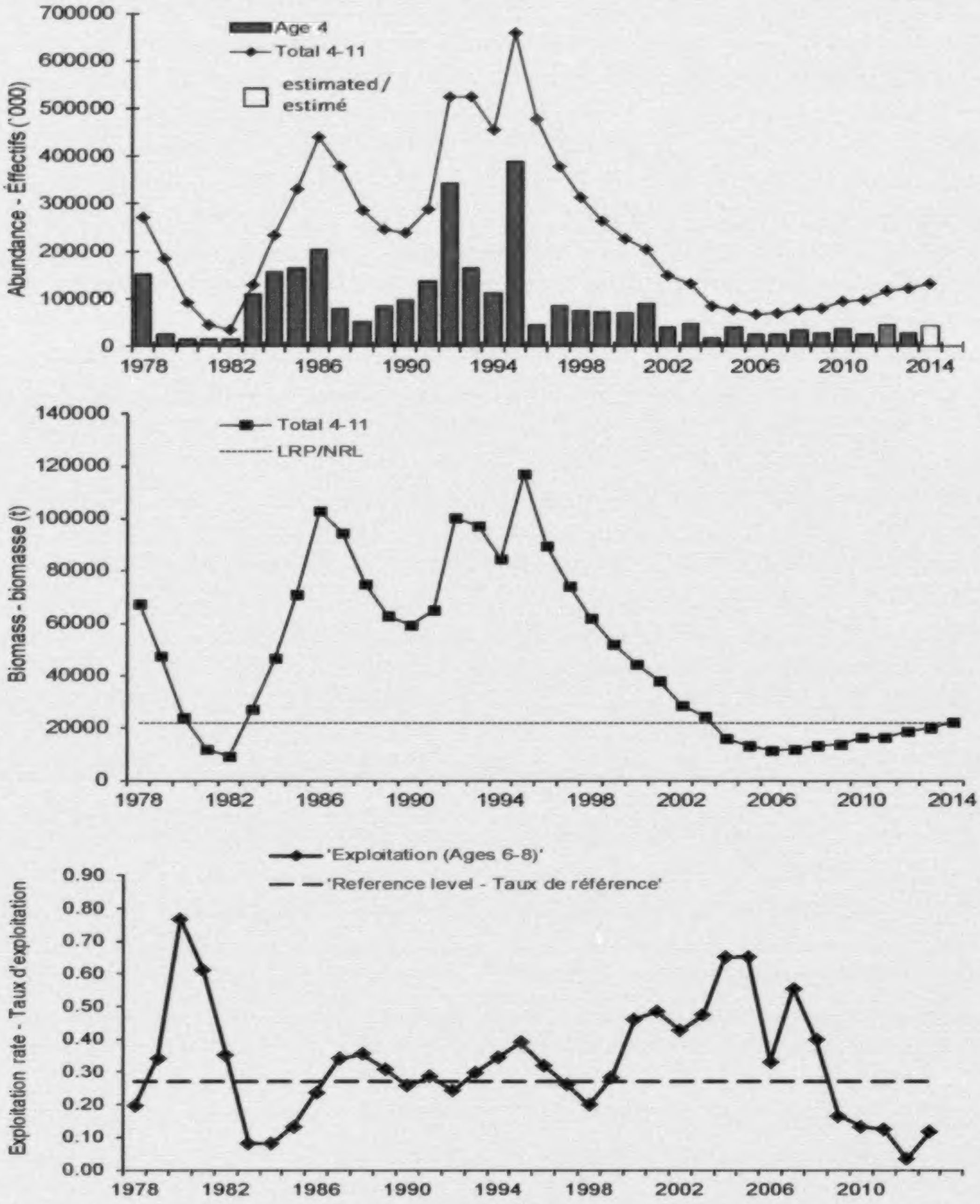


Figure 30. Spring population numbers (ages 4+) and recruitment at age 4 (top: estimated age 4 in 2014 = SSB 2010 x mean age 4 survival ratio from 2009-2013), ages 4+ biomass (center) and exploitation rate (ages 6-8) (bottom) from the ADAPT calibration, 1978 to 2014.

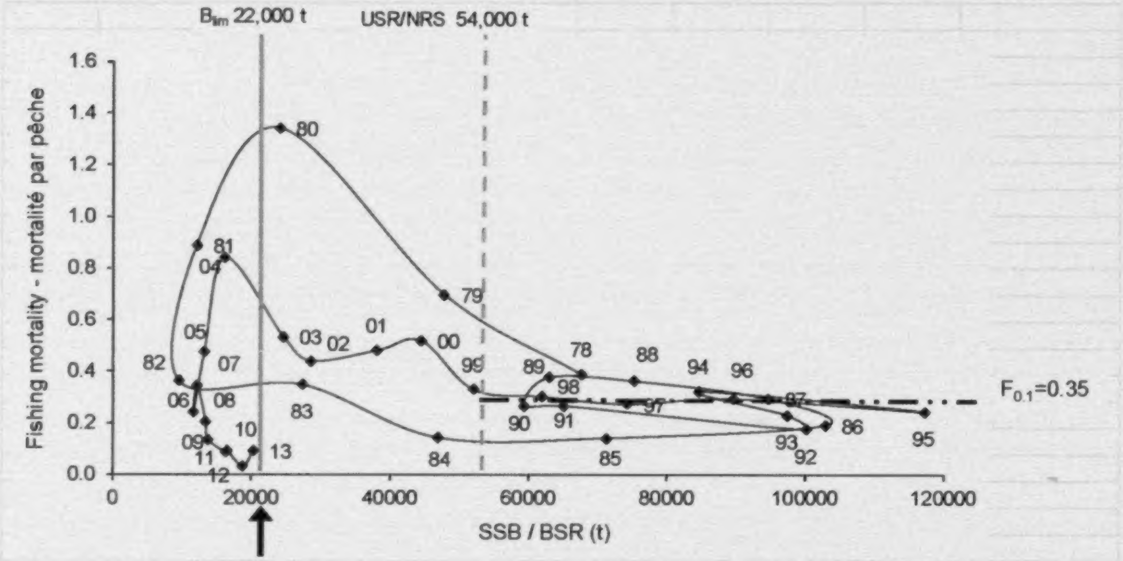


Figure 31. Spring spawning herring stock biomass and exploitation rate trajectories, 1978 to 2013, relative to the reference points. Arrow represents 2014 SSB estimate.

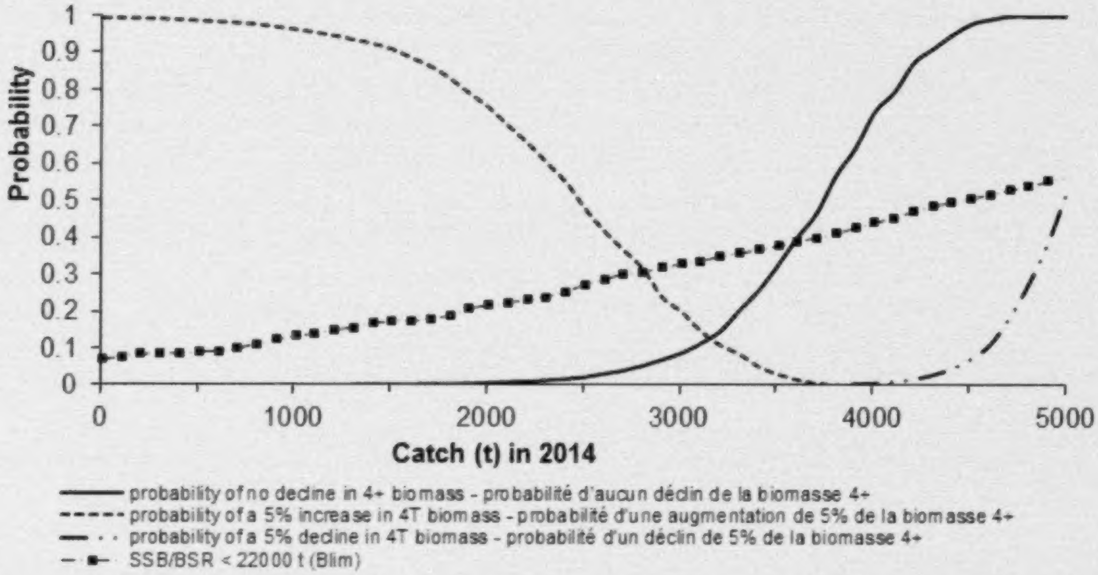


Figure 32. Risk analyses of catch options for spring spawning herring for the 2014 fishery, based on parameters of ages 4+.

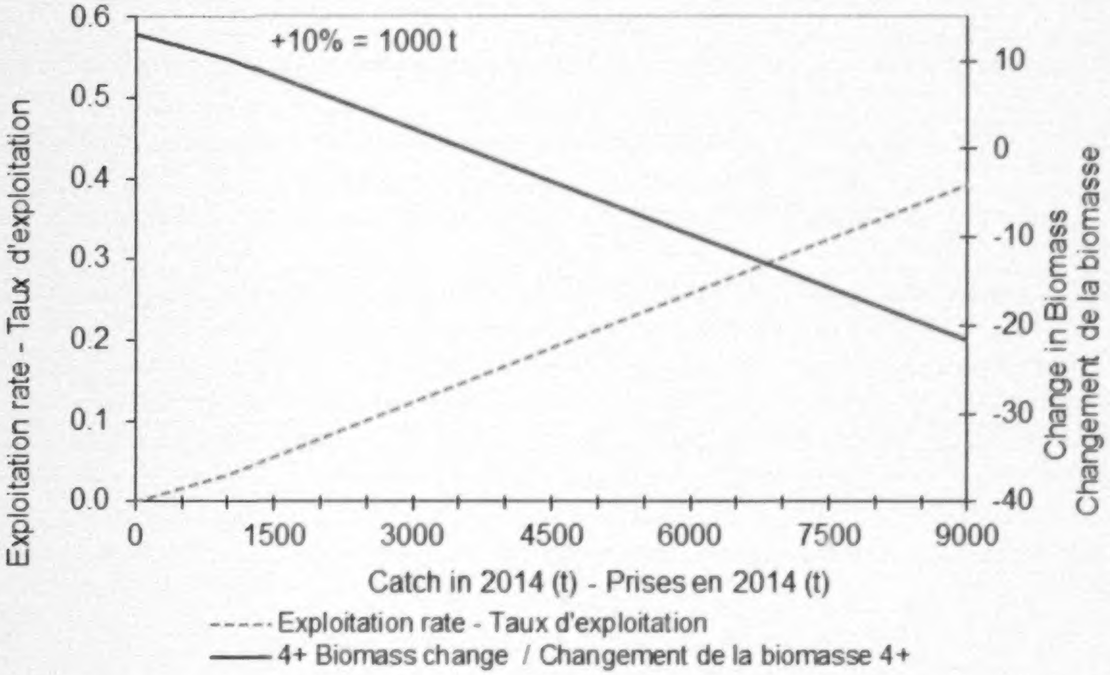


Figure 33. Exploitation rate and change in biomass for various levels of catch for spring spawning herring.

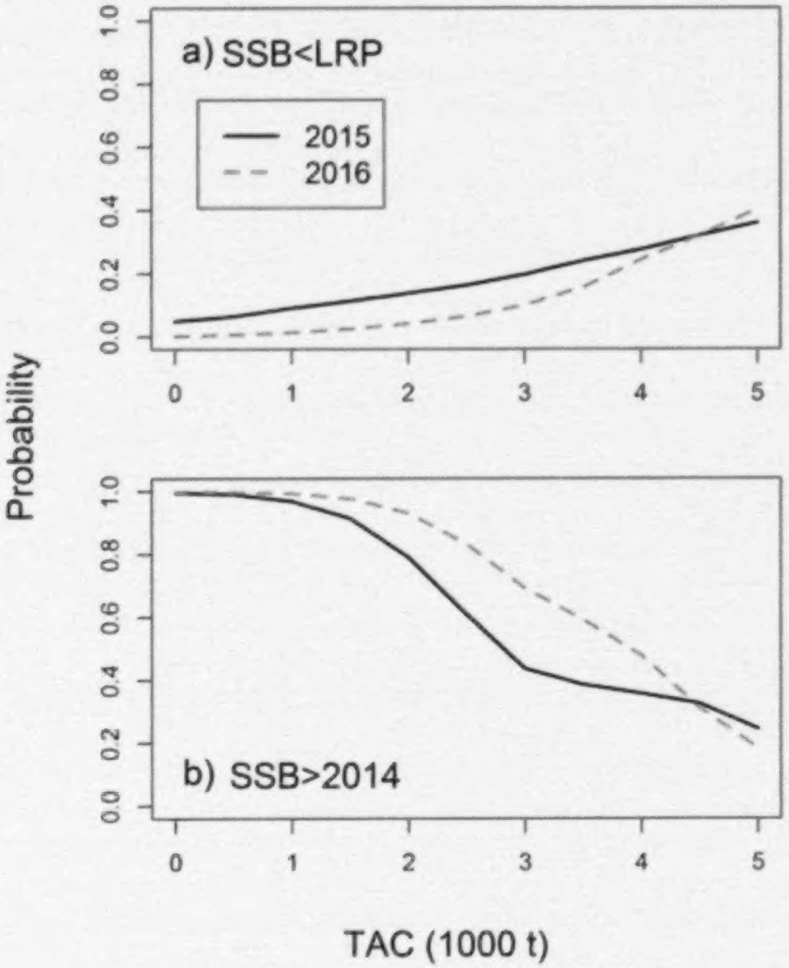


Figure 34. Probability that spawning stock biomass (SSB) of the spring-spawning stock component will be below the limit reference point (LRP = 22000 t) at the beginning of 2015 and 2016 (a; upper panel) or above SSB of 2014 in 2015 and 2016 (b; lower panel) at various fixed levels of catch in 2015 and 2016.

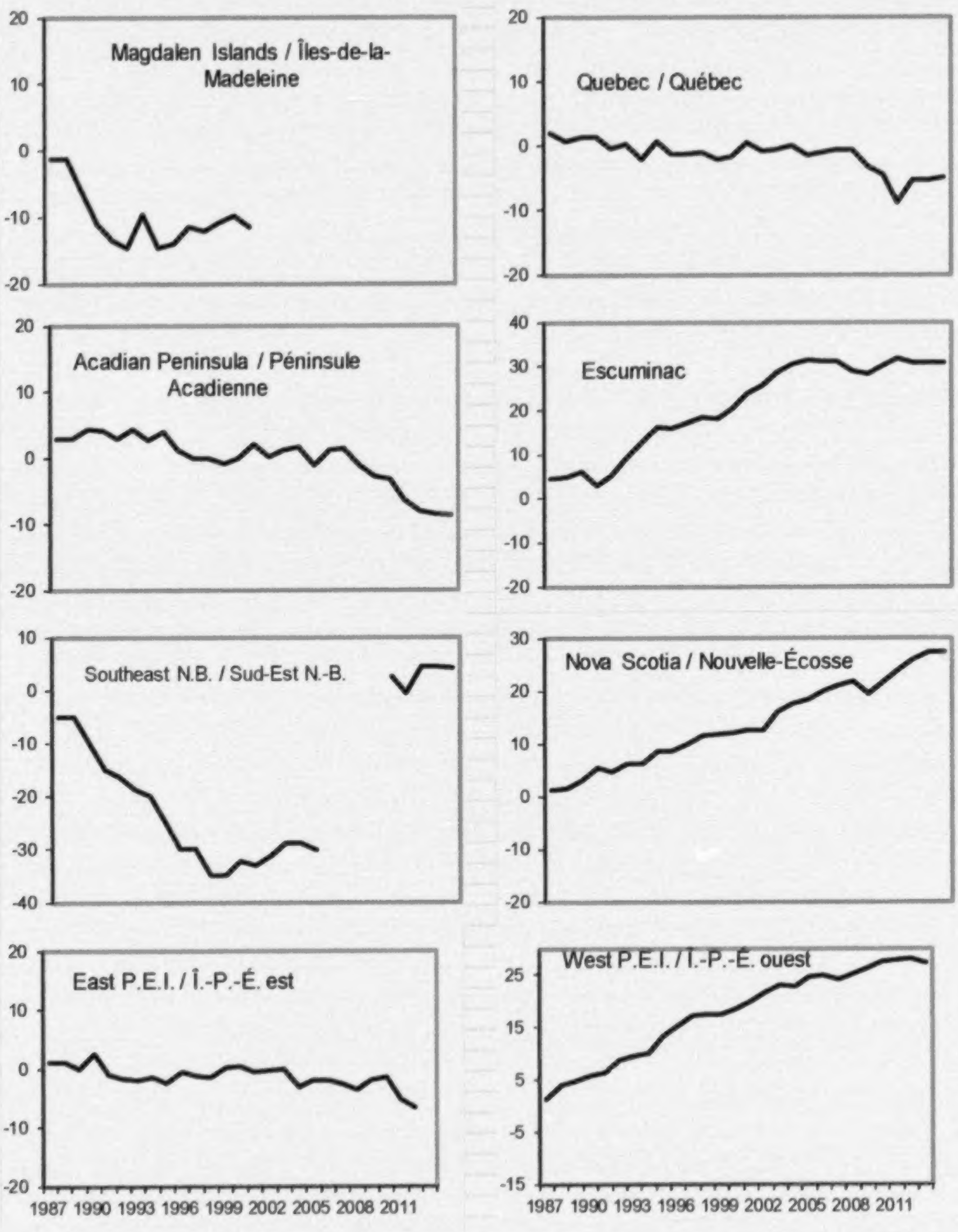


Figure 35. Fall cumulative indices of opinion on abundance by area from the telephone survey, 1987 to 2013.

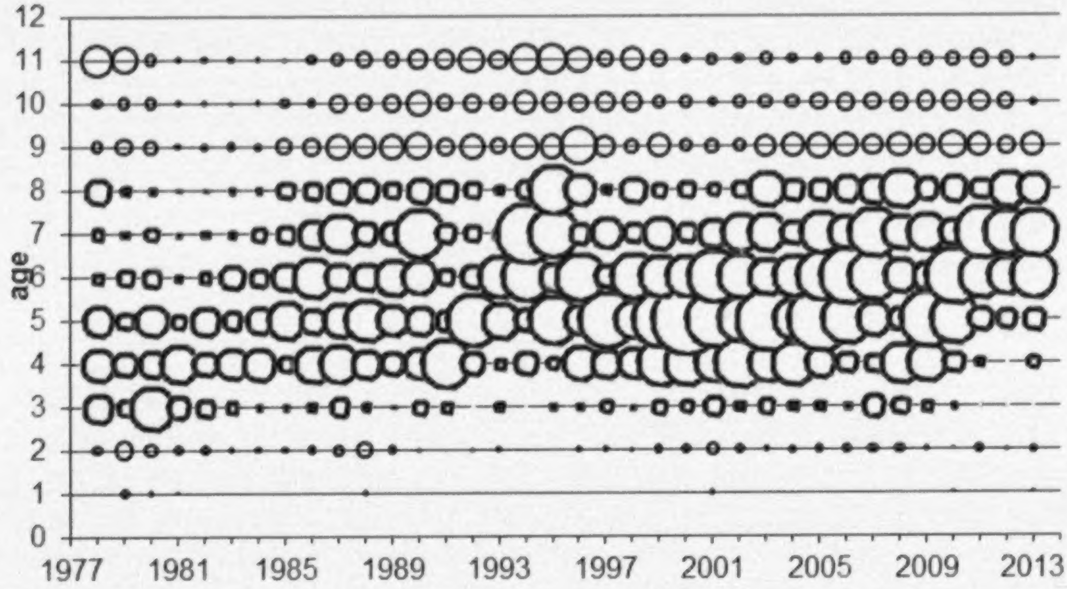


Figure 36. Catch-at-age of fall spawner component from the fishery, all gears combined. Bubbles represent numbers-at-age of total catch.

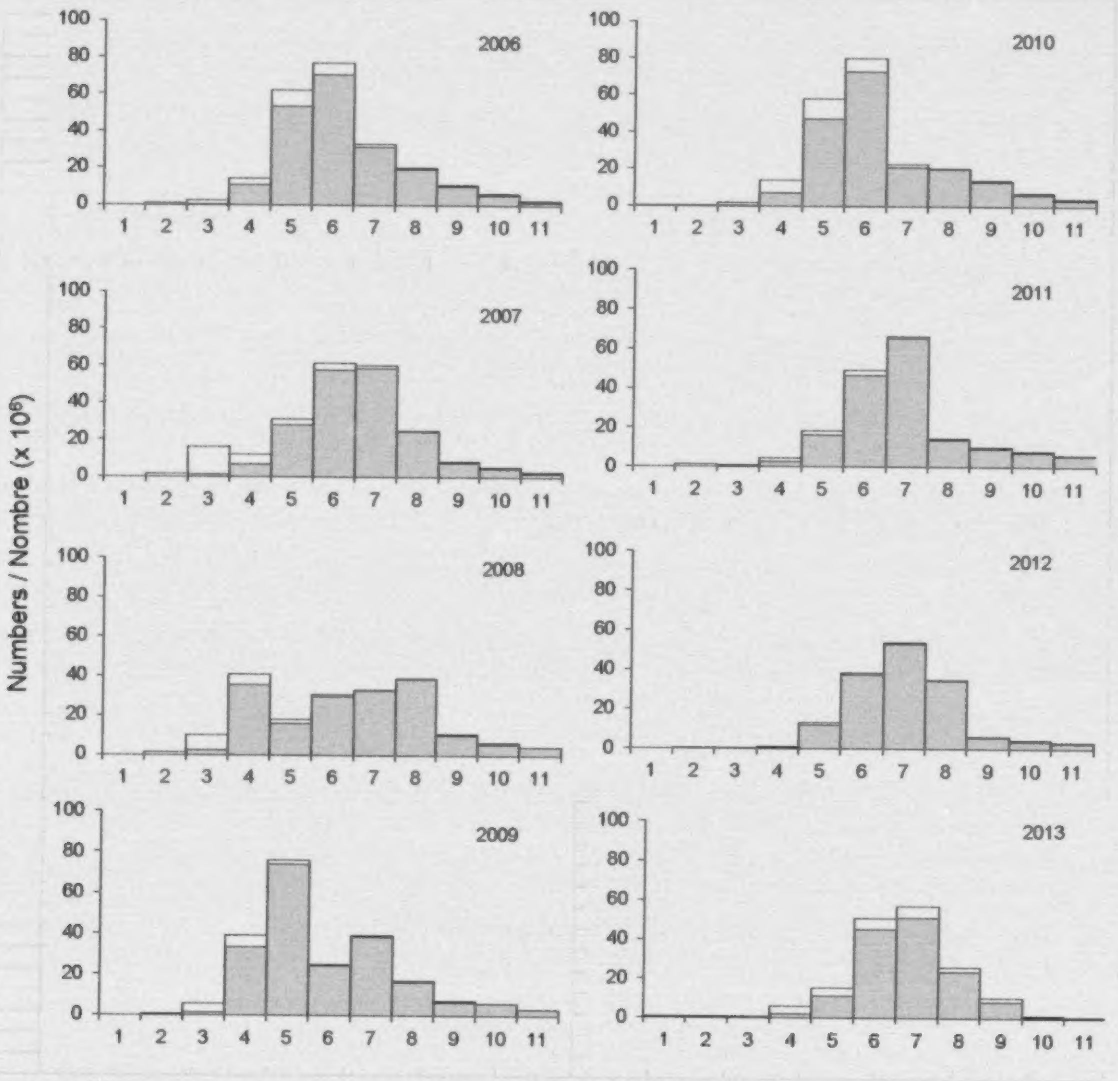


Figure 37. Catch-at-age (2004 to 2013) of fall spawner component from the fishery, all gears combined. Clear portion of bars are mobile gear catches, grey portion of bars are fixed gear catches.

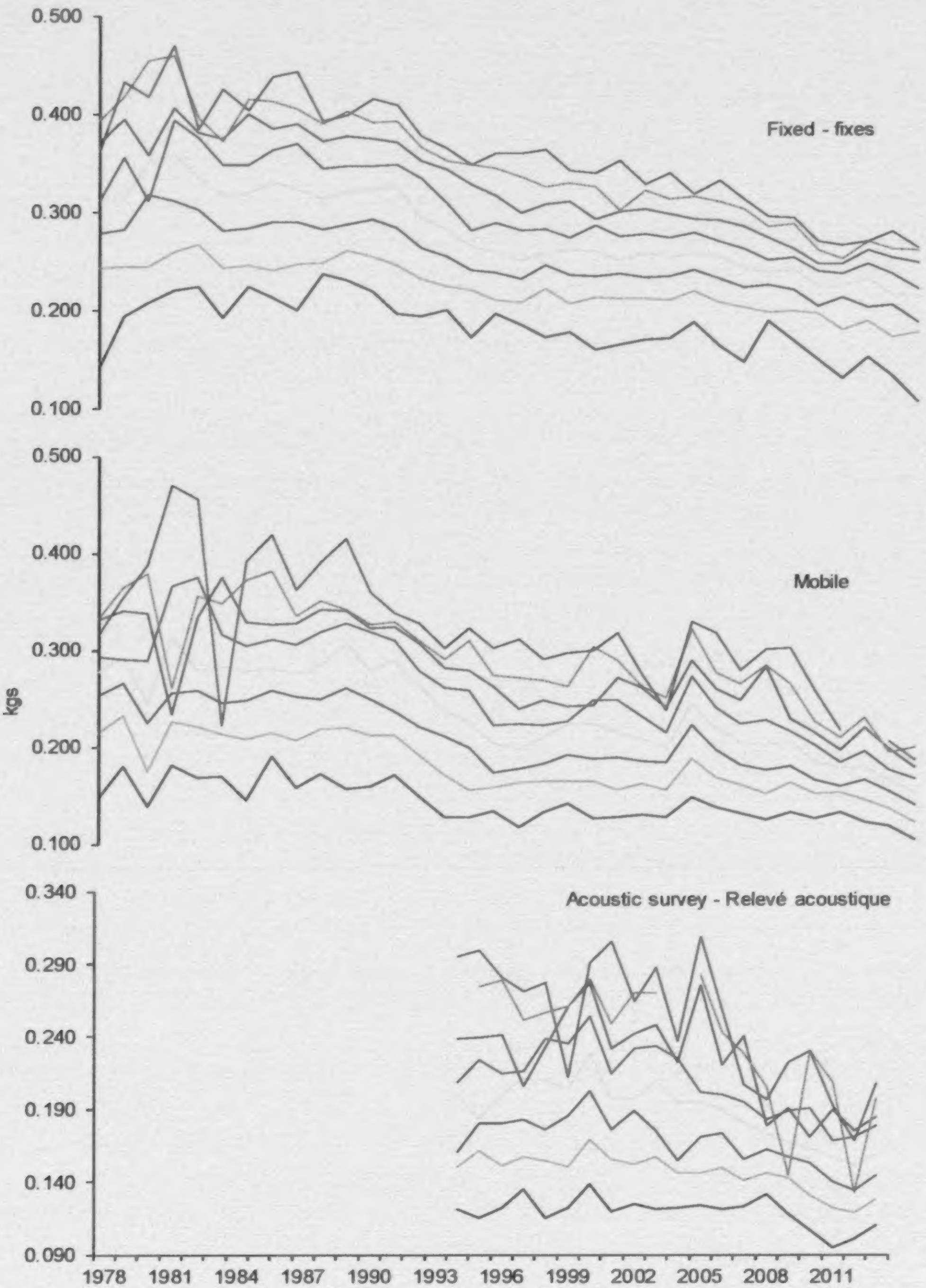


Figure 38. Mean weight-at-age of fall spawners for fixed commercial gear (upper panel), mobile commercial gear (middle panel), and the acoustic survey (lower panel) for ages 3 (bottom line) to 10 (top line).

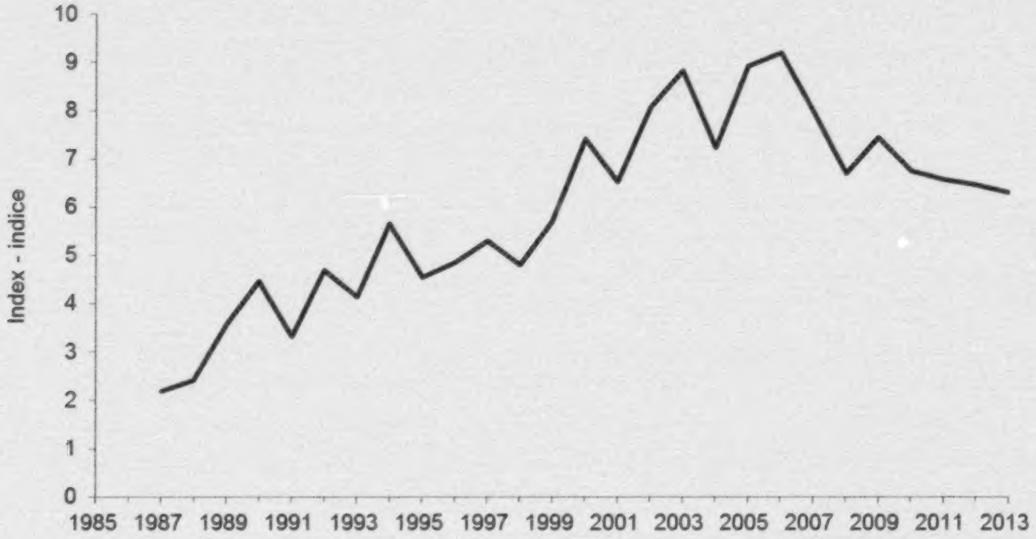


Figure 39. Fall index of opinion on abundance from the telephone survey, for all areas combined, weighted by the catch in each area, 1987 to 2013.

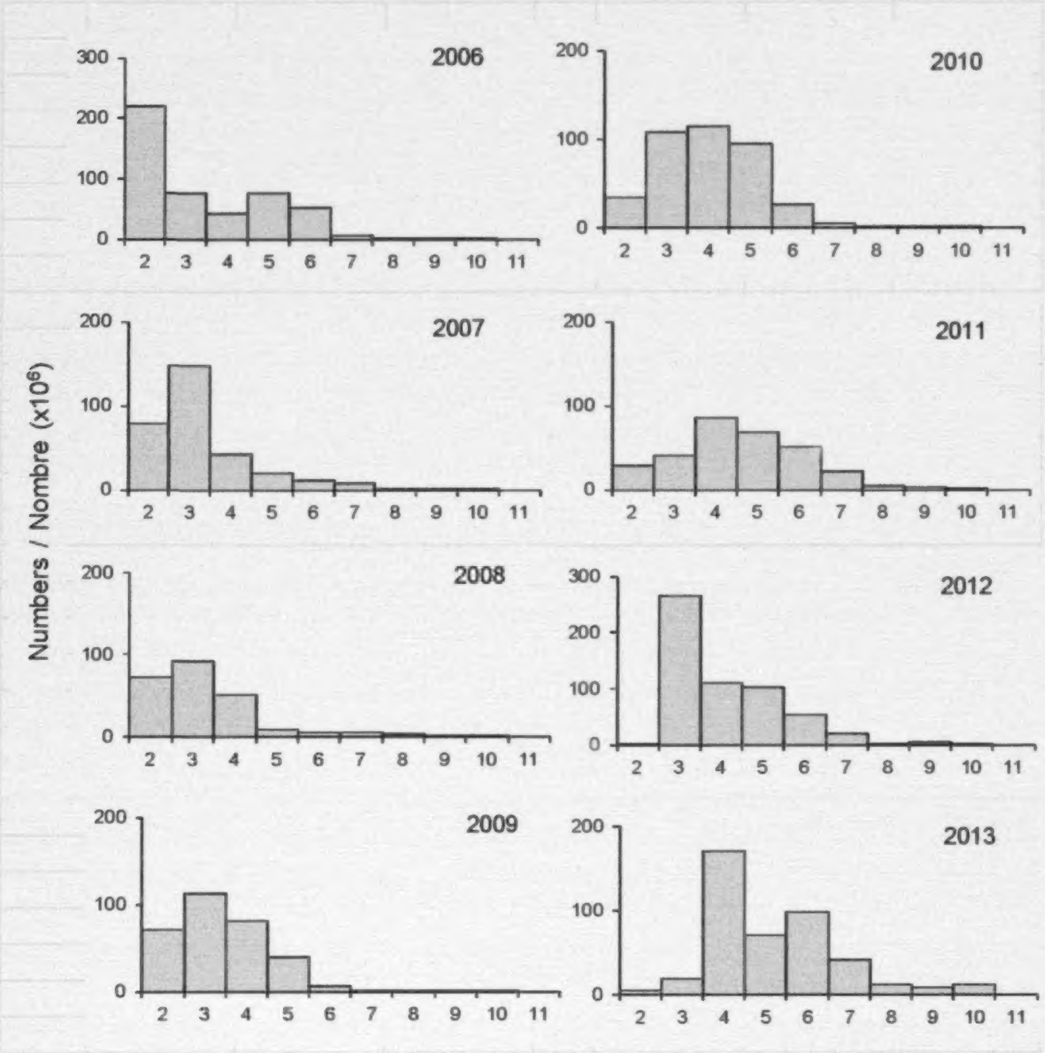


Figure 40. Numbers-at-age (2006 to 2013) of the fall spawner component from the acoustic survey, Chaleurs-Miscou area, for same strata consistently surveyed since 1994.

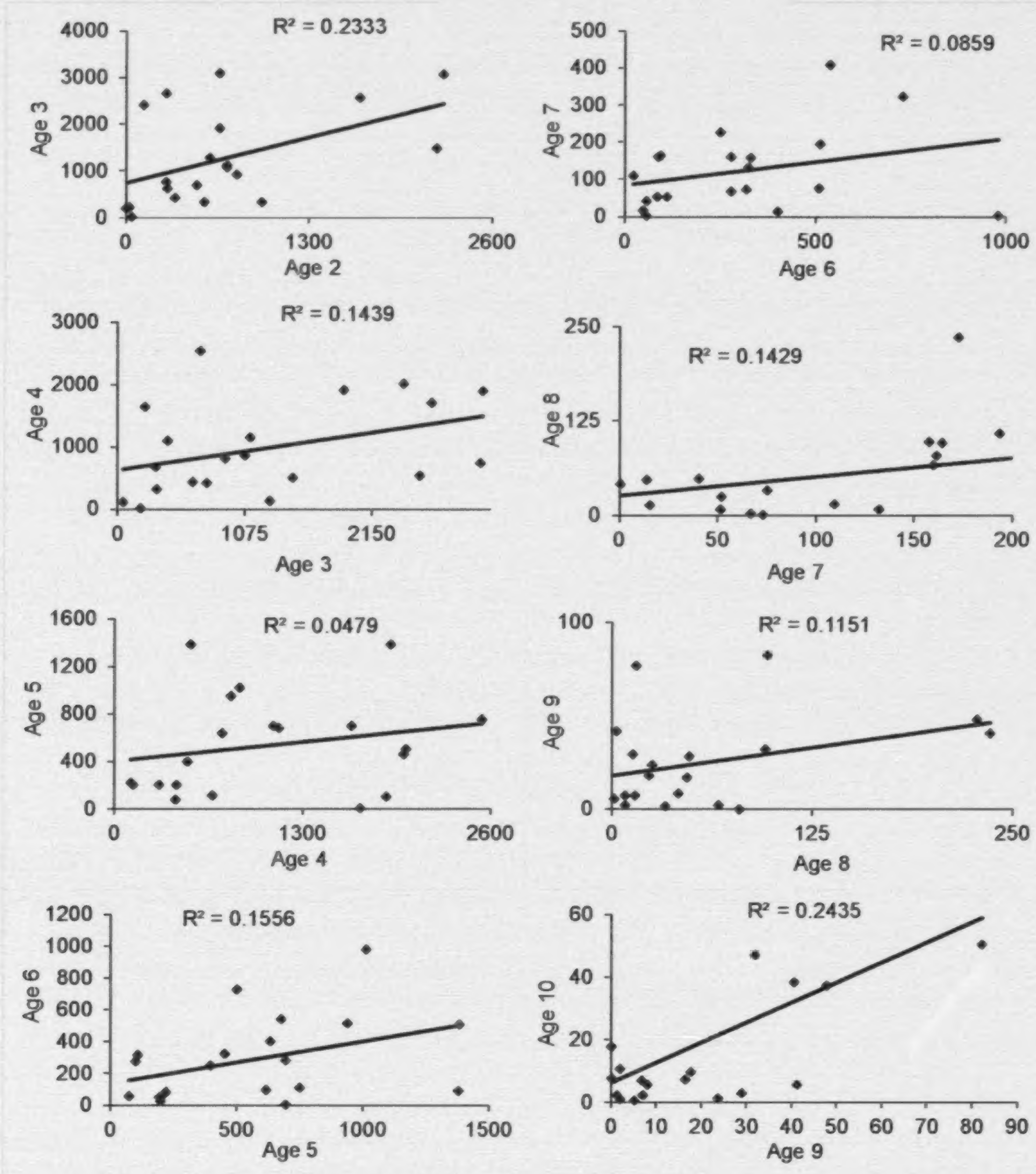


Figure 41. Regression of age-class abundance of fall spawners from one year to the next. The data are from acoustic survey Chaleurs-Miscou same strata surveyed from 1994 to 2013. Catch-at-age in numbers (x 10^5).

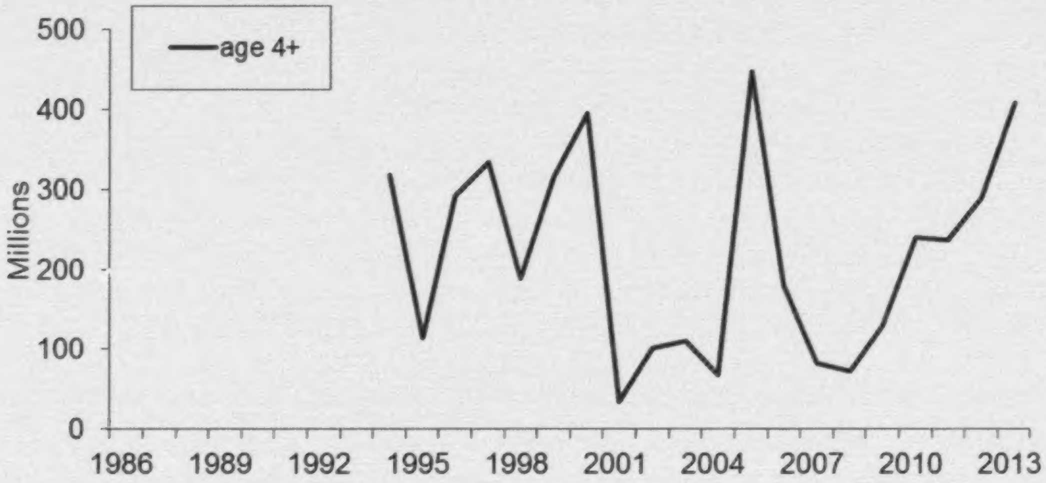


Figure 42. Acoustic survey index of fall spawner component (millions of fish), 1994 to 2013. Data from Chaleurs-Miscou strata consistently surveyed each year since 1994.

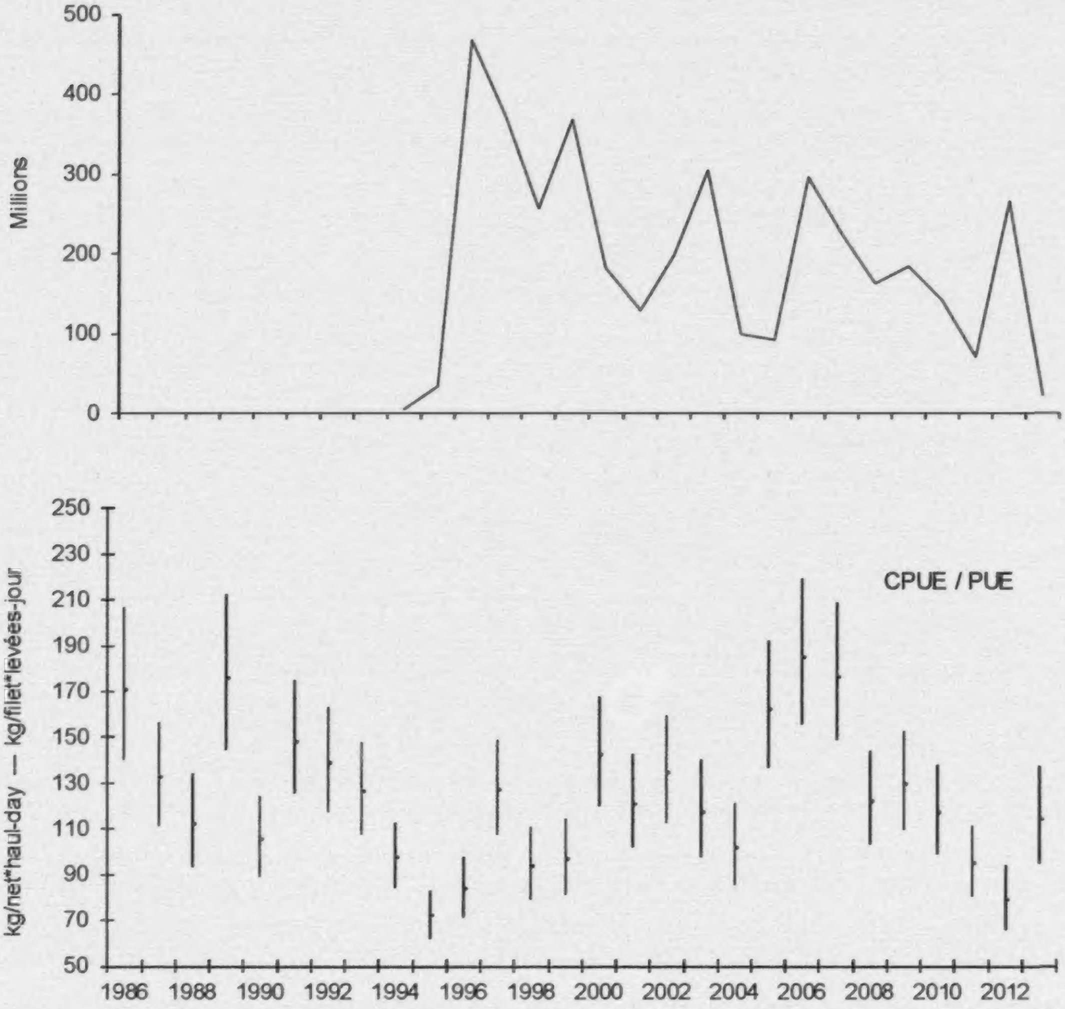


Figure 43. Fall spawner acoustic survey juvenile index (ages 2-3) for 1994 to 2013 (top panel) and gillnet catch rate (CPUE) index for 4T herring for 1986 to 2013 (bottom panel). Error bars indicate approximate 95% confidence intervals.

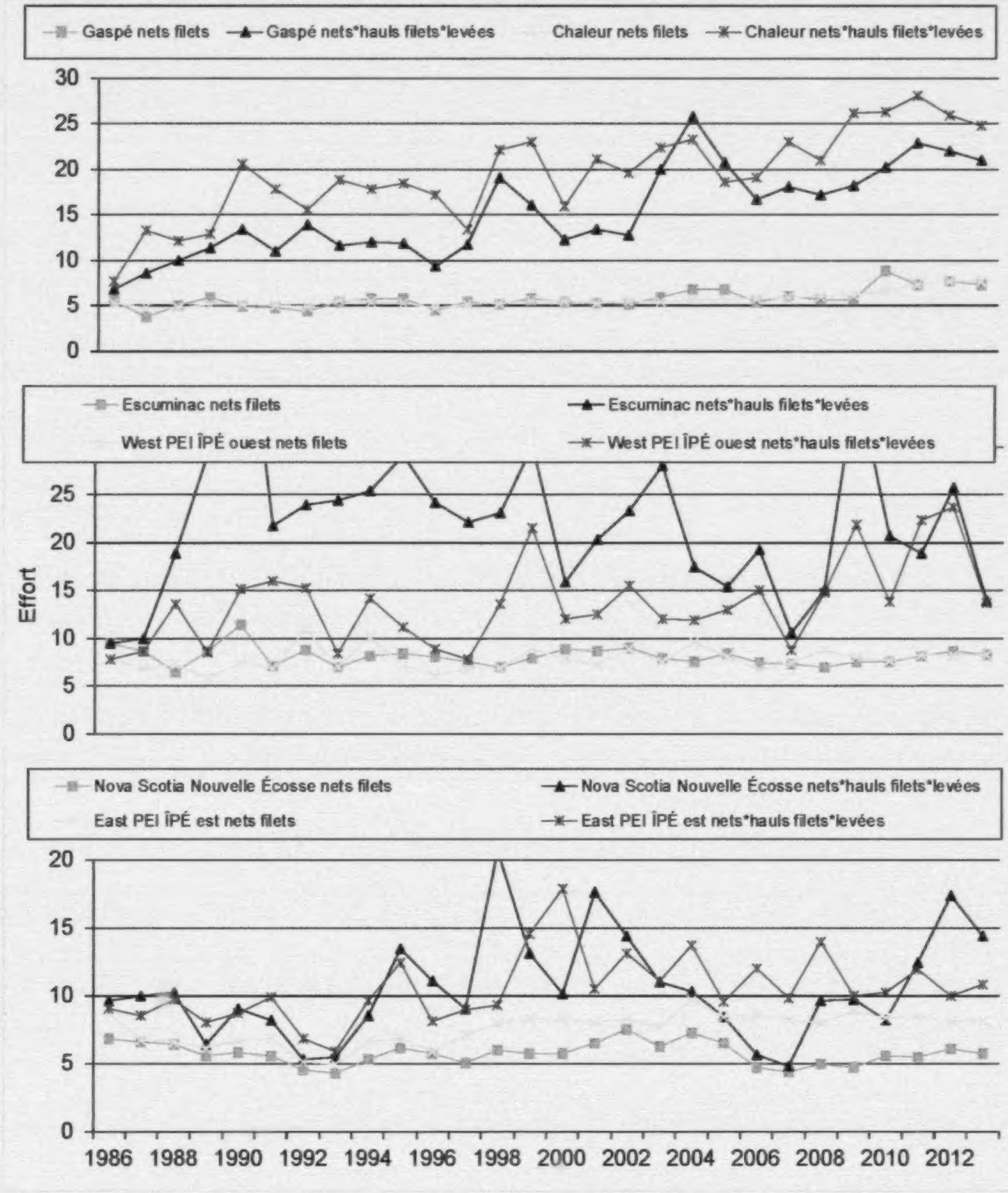


*Figure 44. Average number of standard gillnets of 15 fathoms (nets) and number of net-hauls (net*hauls) from the telephone survey used in the main fishing areas of the fall inshore gillnet fishery, 1986 to 2013.*

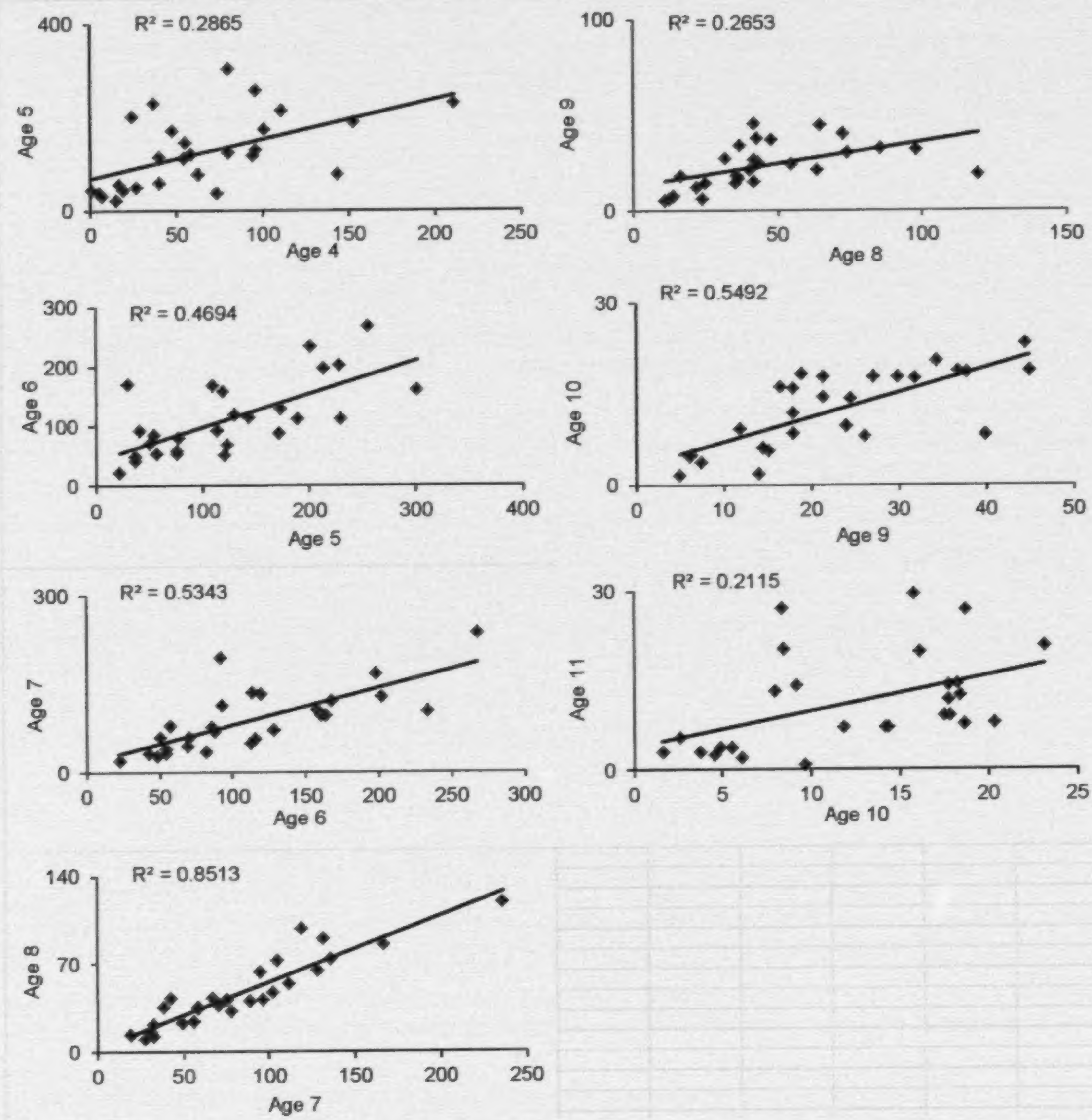


Figure 45. Regression of age-class abundance of fall spawners from one year to the next. The data are from gillnet catch rates CPUE as numbers of herring.

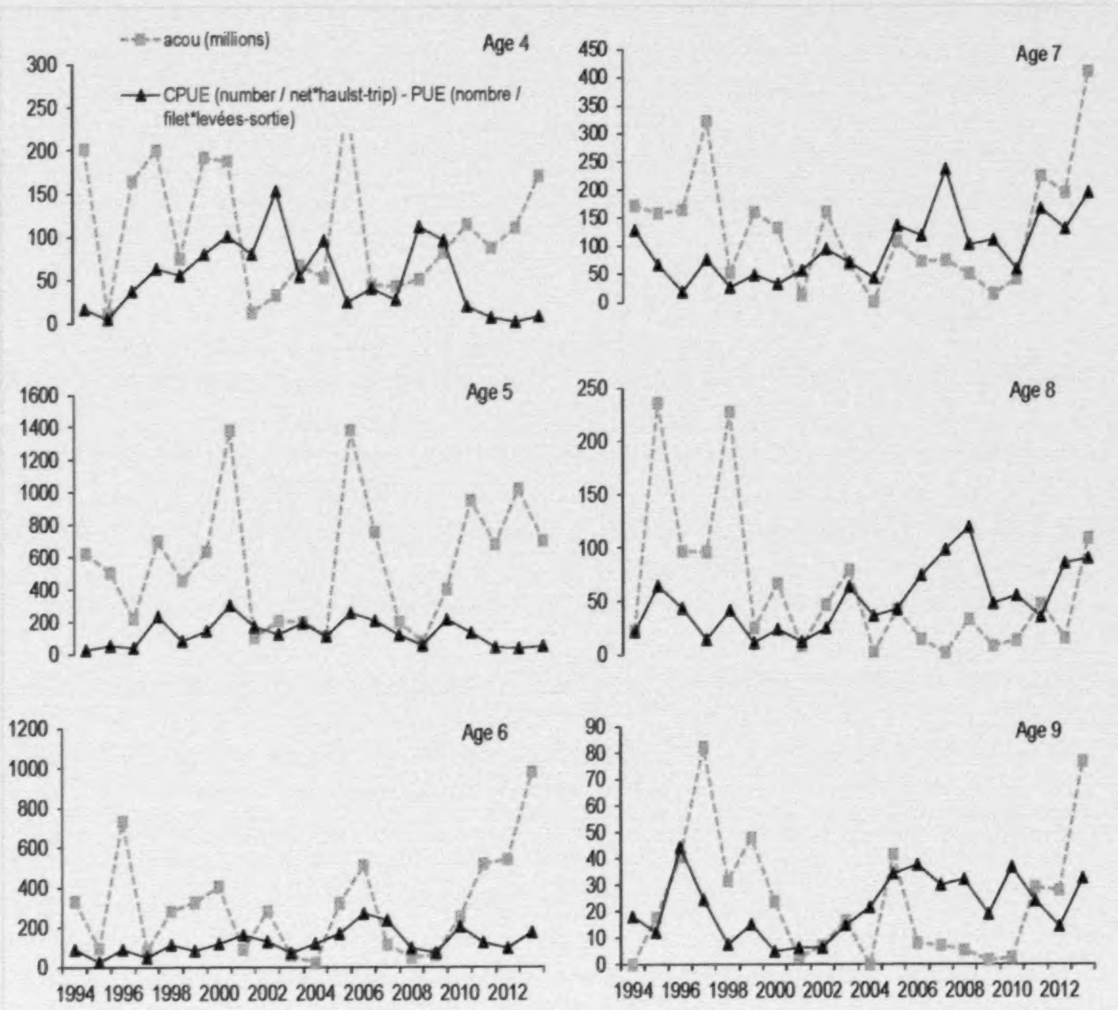


Figure 46. Comparison of fall gillnet CPUE index and the acoustic survey index for ages 4 to 9 years, 1994 to 2013..

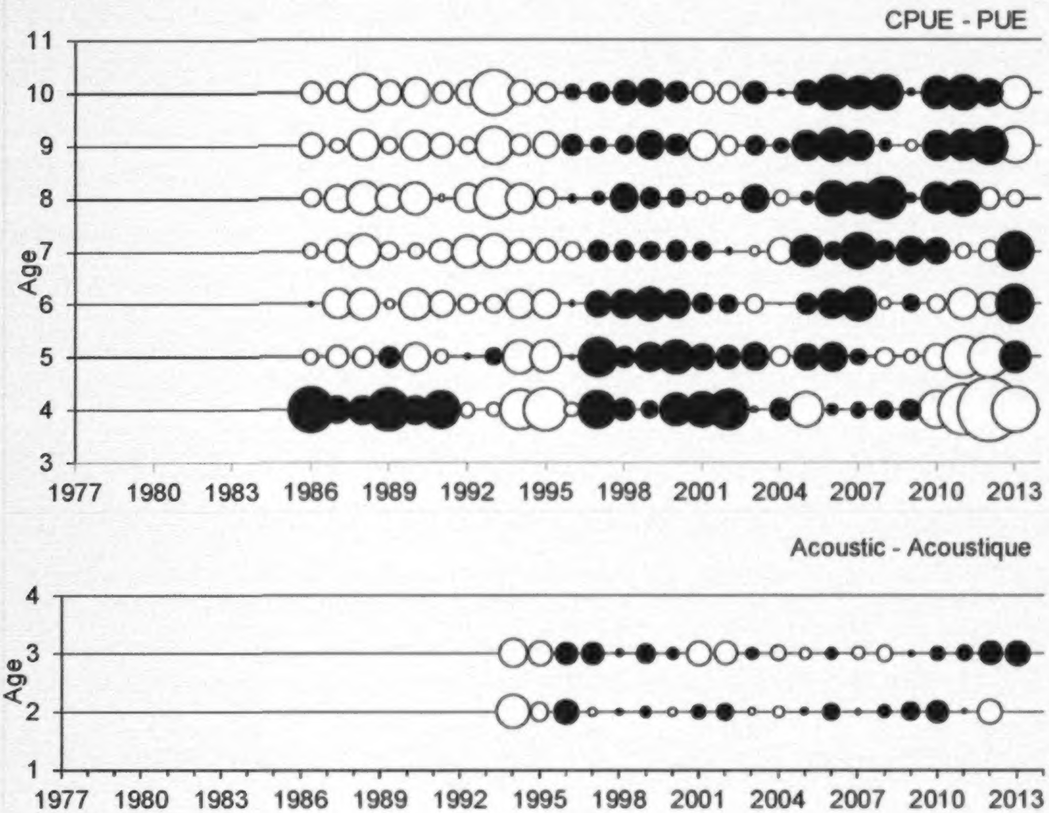


Figure 47. MODEL 1: Residuals for the ADAPT calibration of the fall spawner SPA using the age disaggregated gillnet CPUE and acosutic indices. Circles indicate relative residual size (black is positive; white is negative).

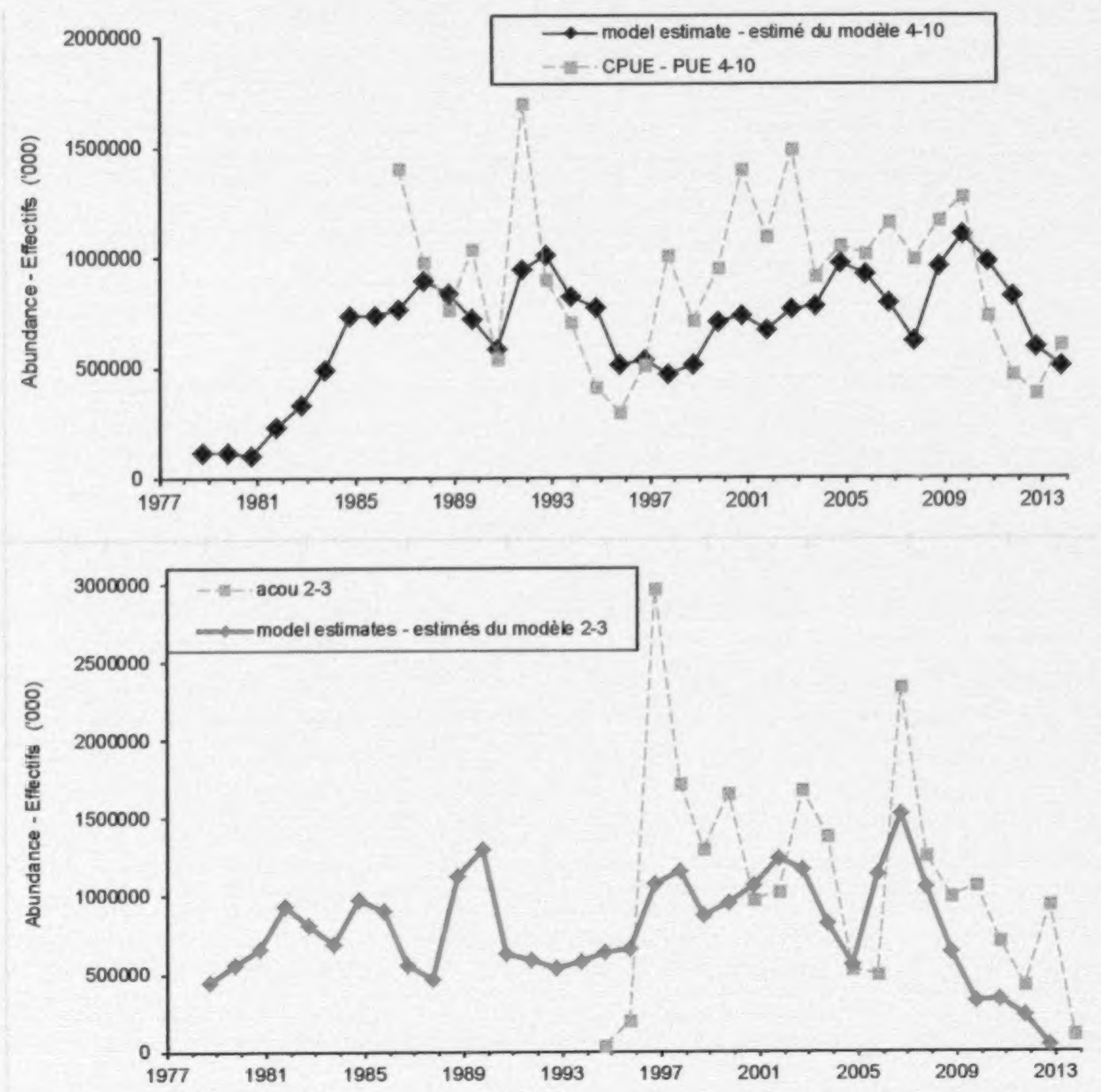


Figure 48. MODEL 1: Comparison of CPUE (upper panel) and acoustic (lower panel) indices, corrected for catchability, and model estimates of population abundance for 4T herring fall spawner component, 1978 to 2013.

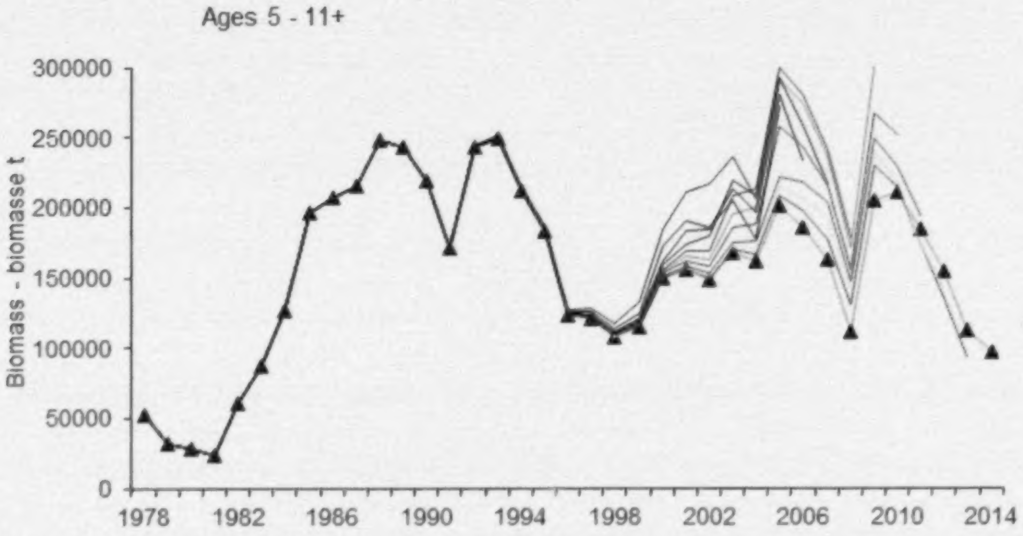


Figure 49. MODEL 1: Retrospective patterns in the fall spawner ADAPT-VPA using the age disaggregated gillnet CPUE and acoustic (ages 2-3) indices (triangles = 2014).

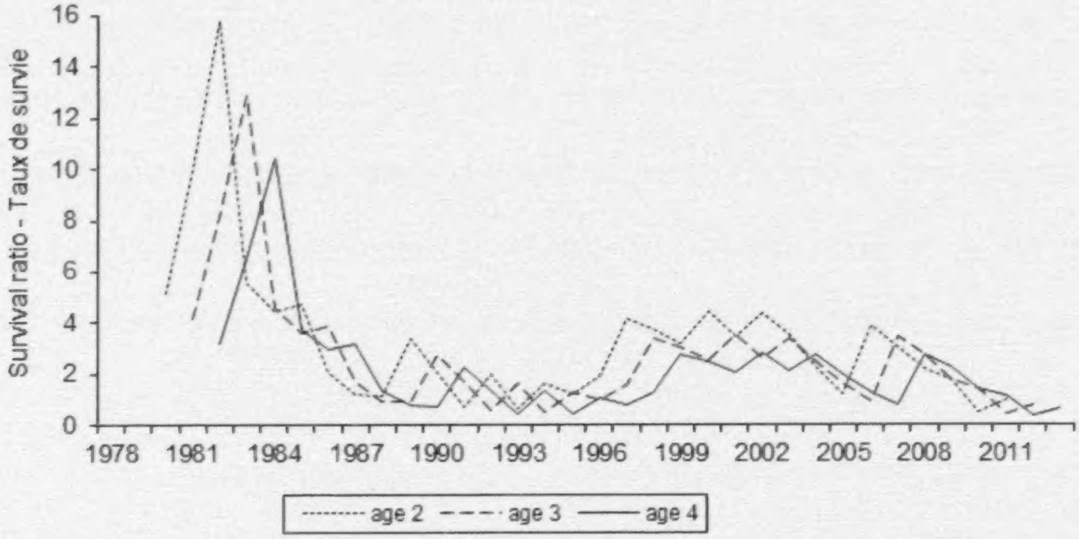


Figure 50. MODEL 1: Survival ratio (age n abundance in year t / SSB in year t-n) for fall spawner recruits for ages 2, 3, and 4 years, 1980 to 2013.

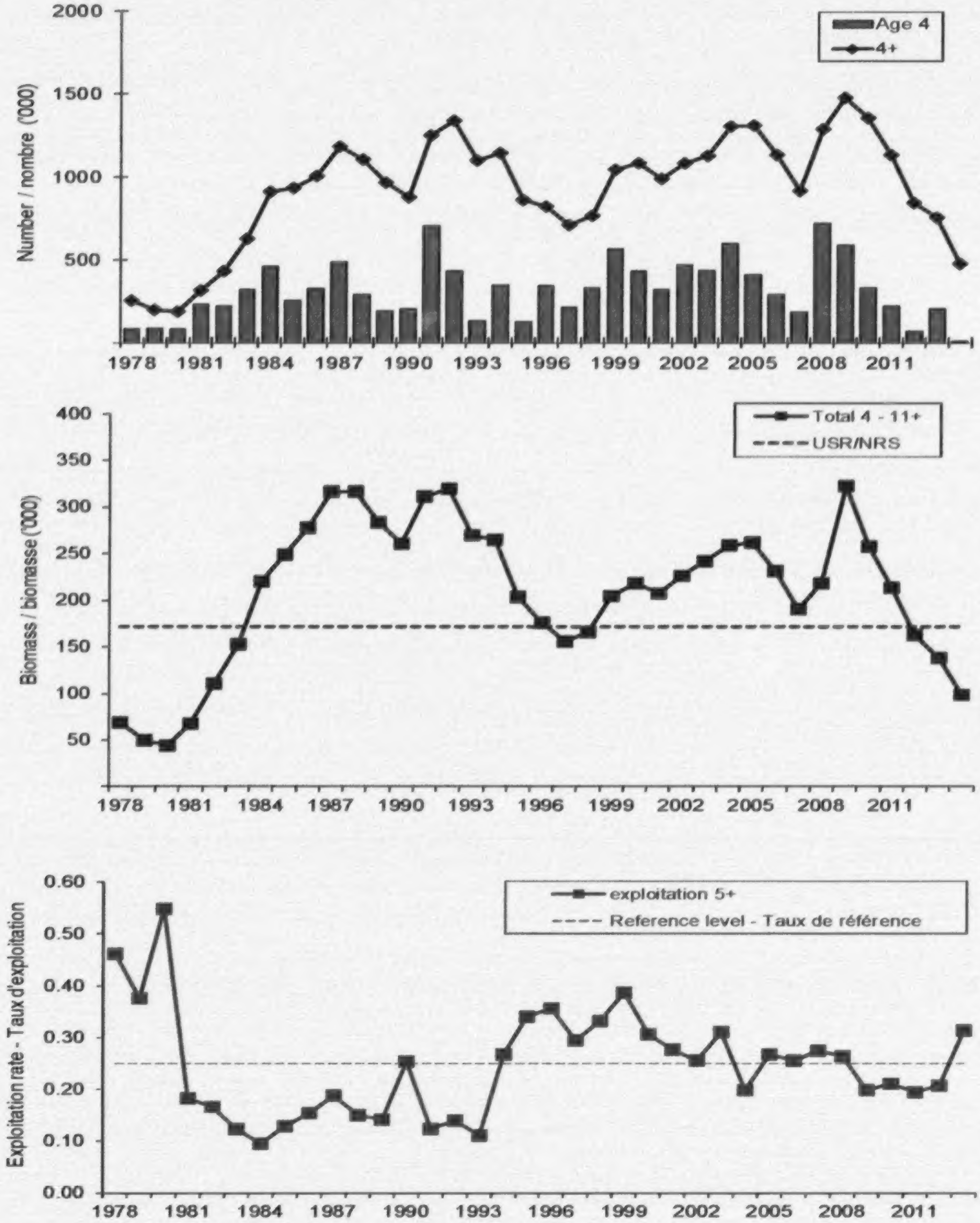


Figure 51. MODEL 1: Fall spawner population numbers (4+) and recruitment at age 4 (top panel), biomass (middle panel) and age 5+ exploitation rate (bottom panel) from the 2013 numbers from the ADAPT calibration with the gillnet CPUE and acoustic (ages 2-3) indices.

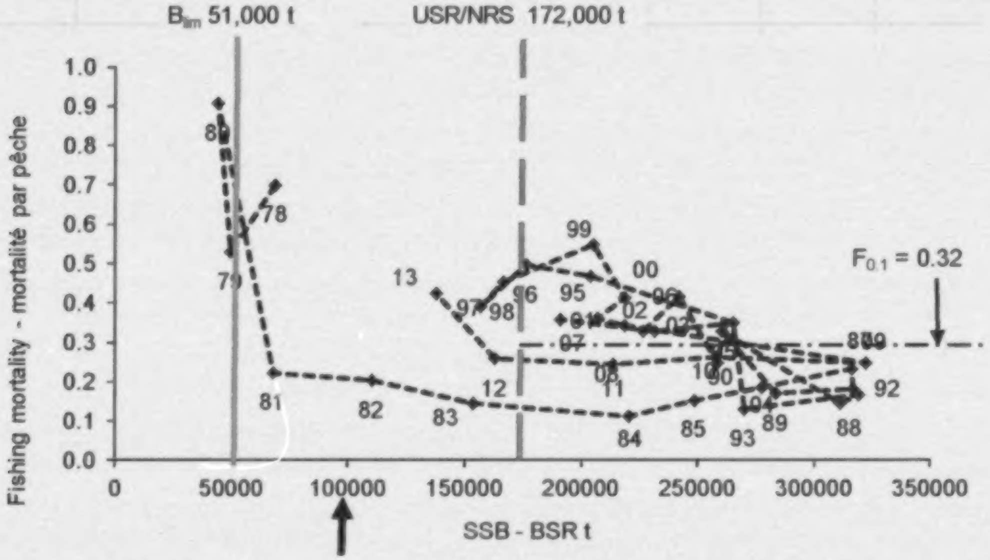


Figure 52. MODEL 1: Fall spawning herring spawning stock biomass and exploitation rate trajectories, 1978 to 2013, relative to the reference points. Arrow indicates the 2014 SSB estimate.

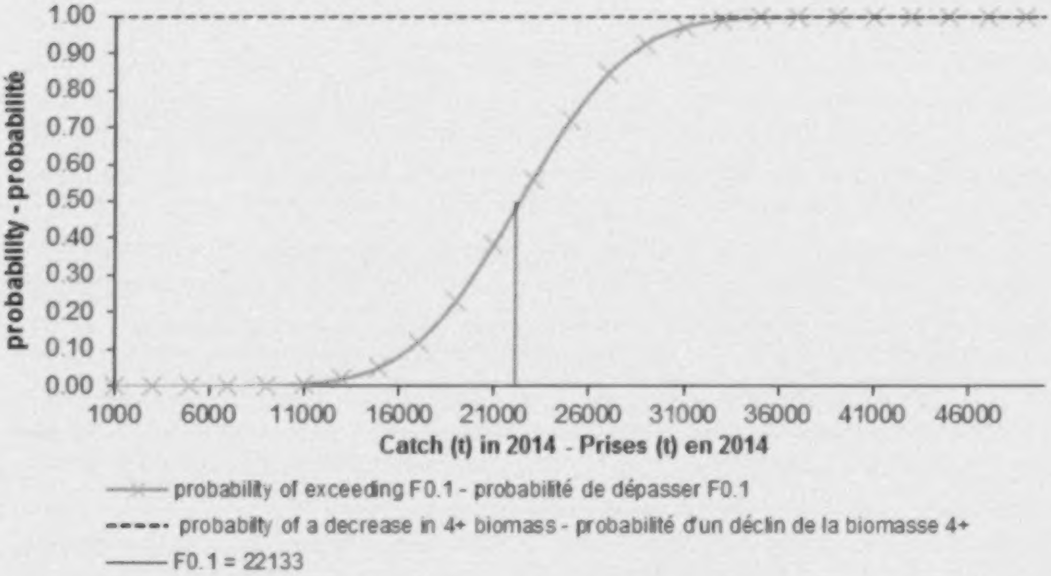


Figure 53. MODEL 1: Risk analyses of catch options for 2014 for fall spawning herring using parameters for ages 4 to 11+.

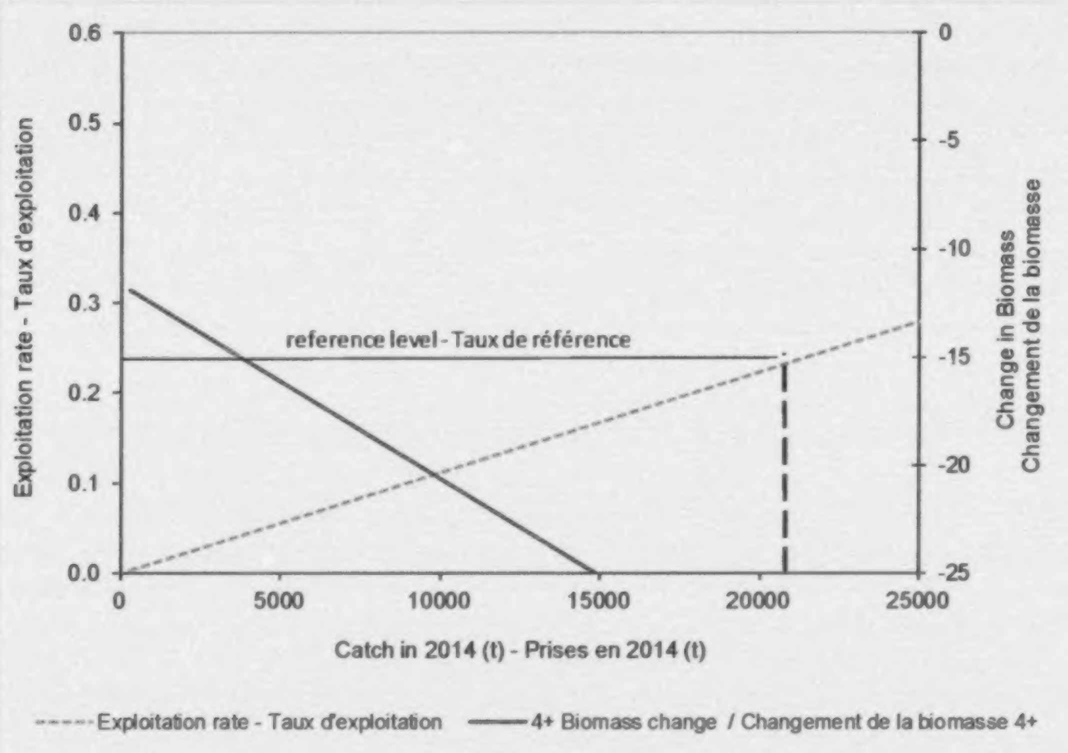


Figure 54. MODEL 1: Exploitation rate and change in biomass for various levels of catch for fall spawning herring. The catch in 2014 corresponding to the exploitation rate reference level is 22,133 t.

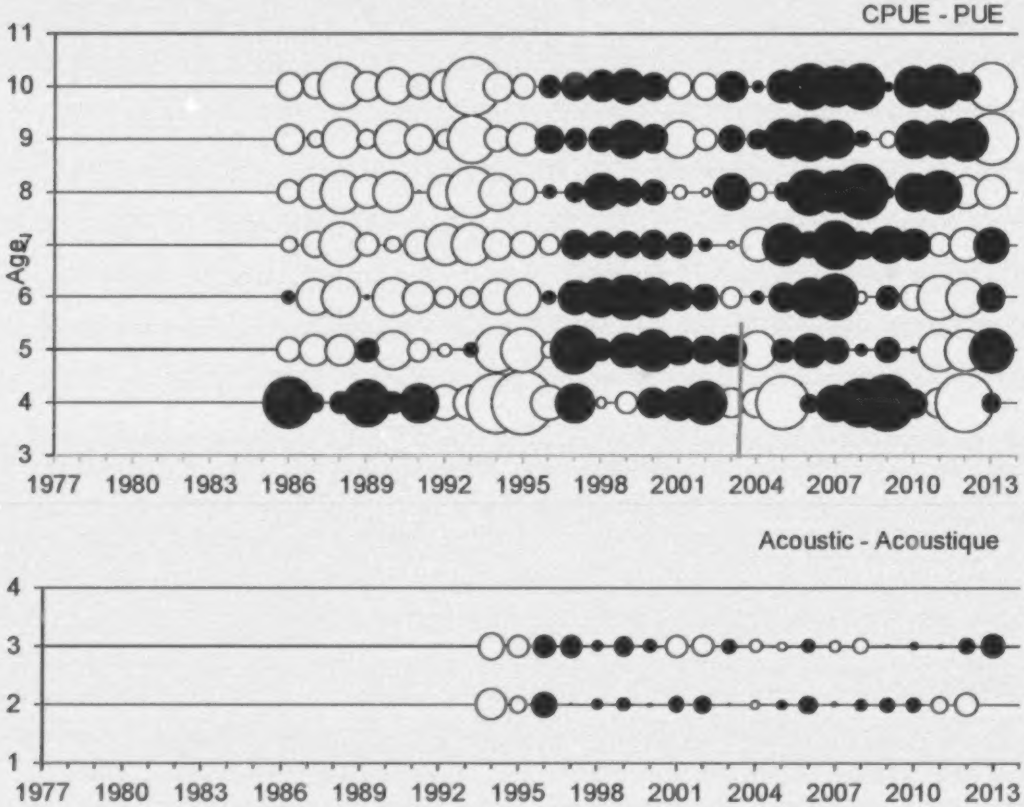


Figure 55. MODEL 2: SPLIT CPUE Residuals for the ADAPT calibration of the fall spawner SPA using the split age disaggregated gillnet CPUE indices and the juvenile acoustic index. Circles indicate relative residual size (black is positive; white is negative). Line represents split CPUE for ages 4 and 5.

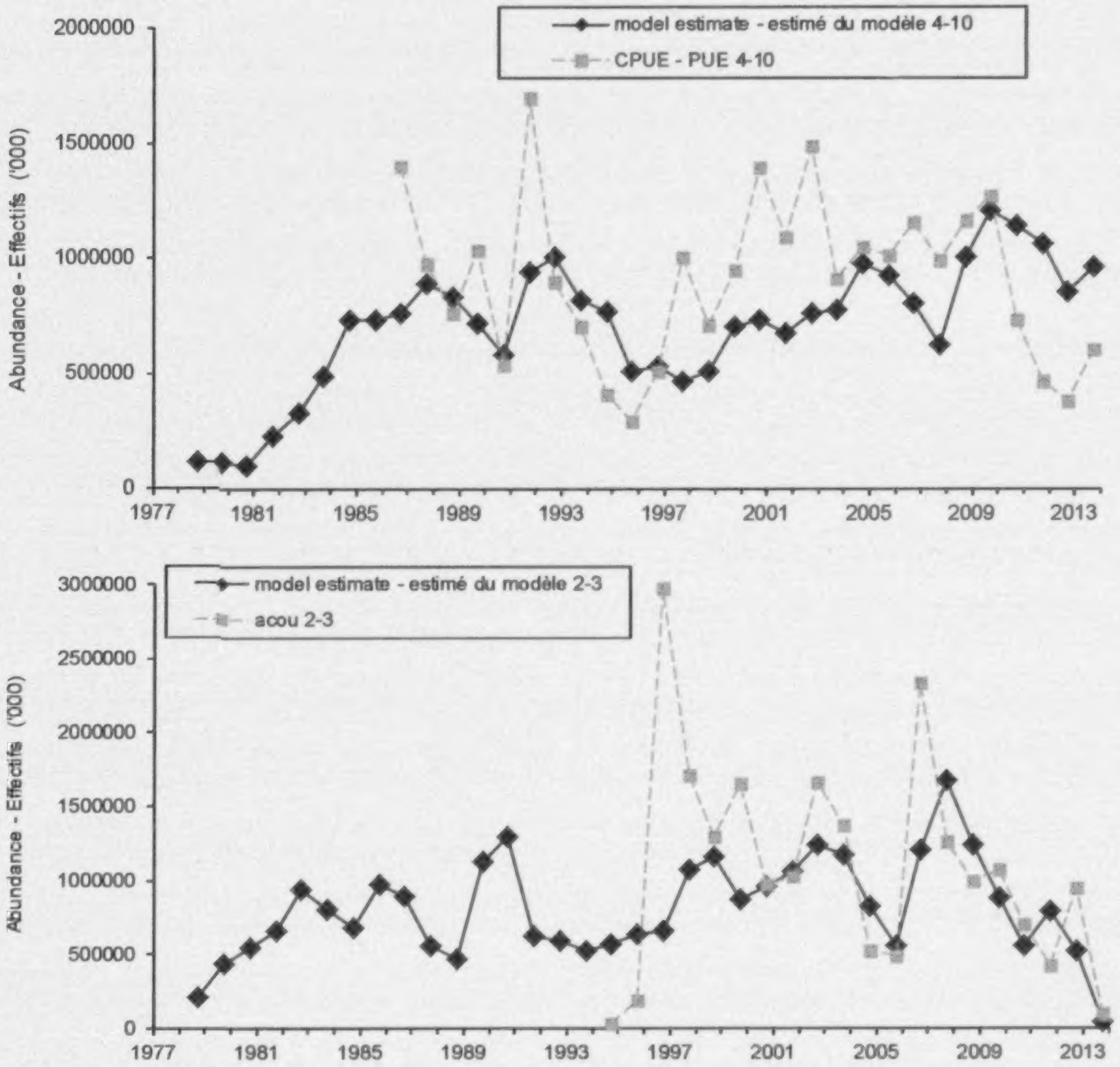


Figure 56. MODEL 2: SPLIT CPUE Comparison of CPUE (upper panel) and acoustic (lower panel) indices, corrected for catchability, and model estimates of population abundance for 4T herring fall spawner component, 1978 to 2013.

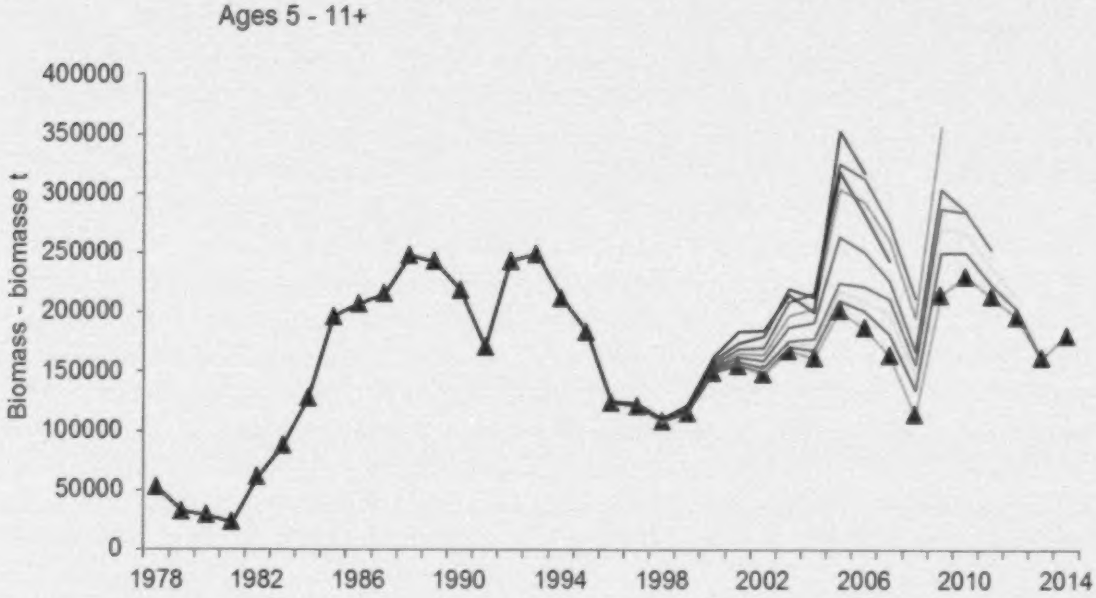


Figure 57. MODEL 2: SPLIT CPUE Retrospective patterns in the fall spawner ADAPT-VPA using the split age disaggregated gillnet CPUE indices and acoustic (ages 2-3) index (triangles = 2014).

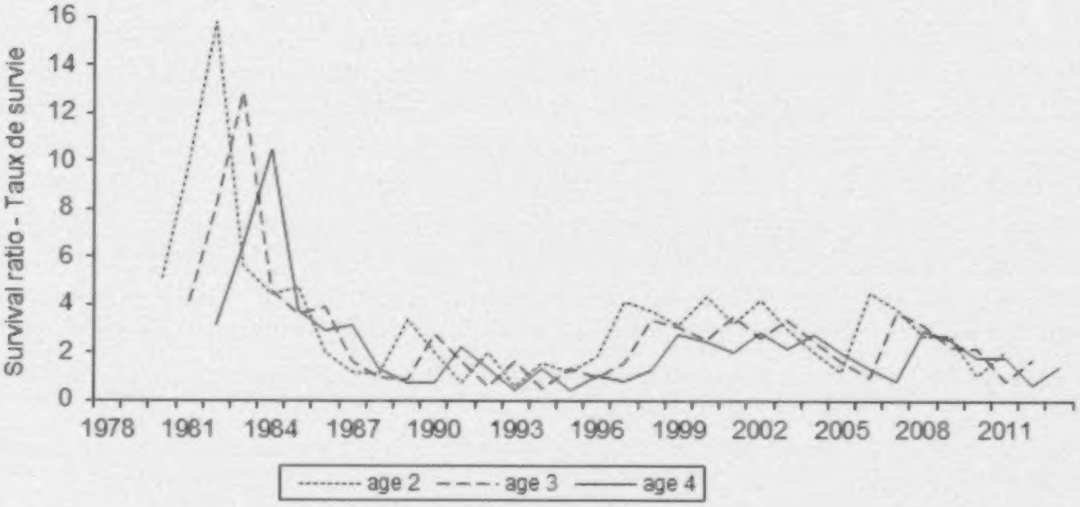


Figure 58. MODEL 2: SPLIT CPUE Survival ratio (age n abundance in year t / SSB in year t-n) for fall spawner recruits, ages 2 to 4 years, 1980 to 2013.

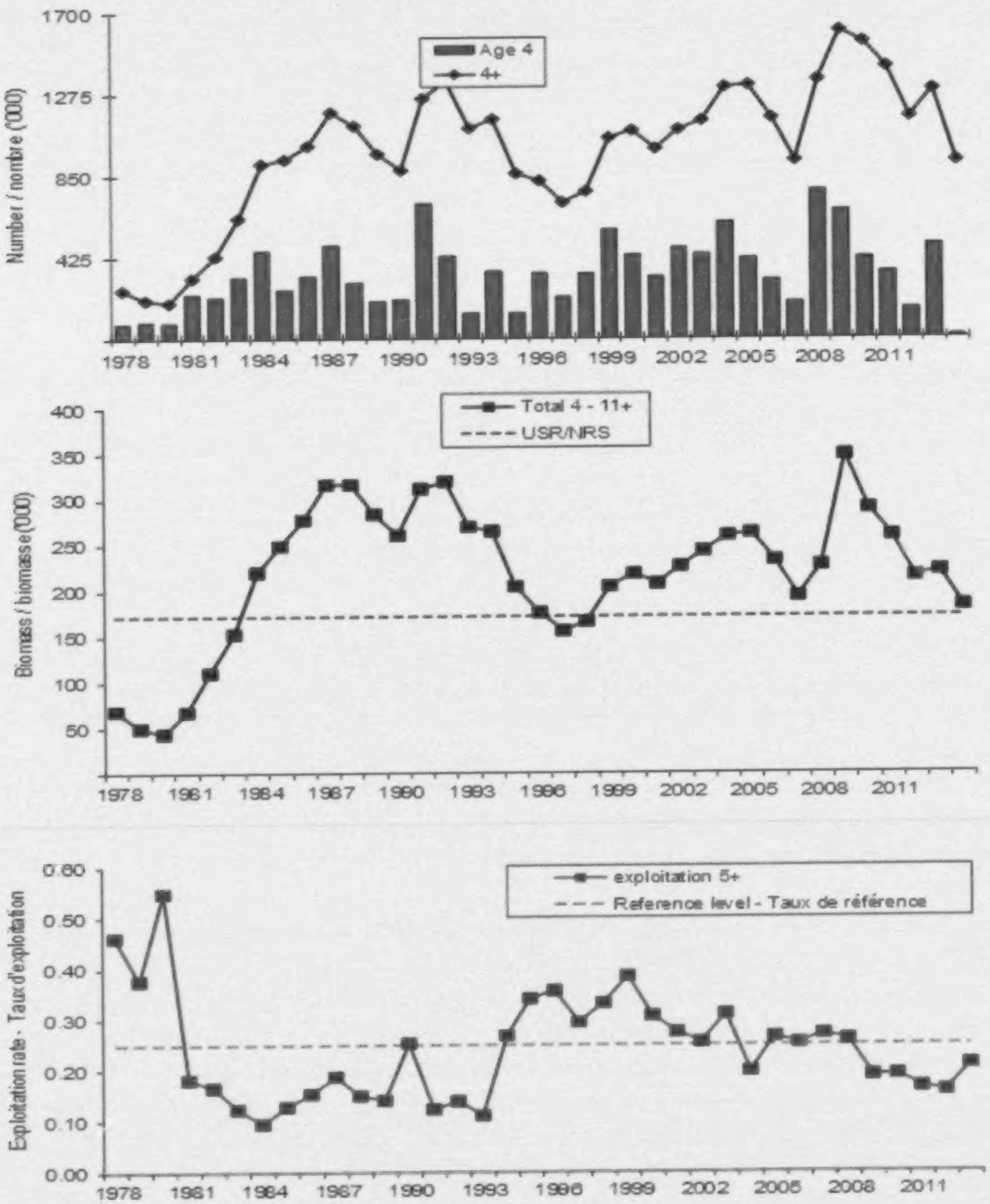


Figure 59. MODEL 2: SPLIT CPUE Fall spawner population numbers (4+) and recruitment at age 4 (top panel), biomass (middle panel) and age 5+ exploitation rate (bottom panel) from the 2014 numbers from the ADAPT calibration with the split gillnet CPUE indices and acoustic (ages 2-3) index, 1978 to 2013.

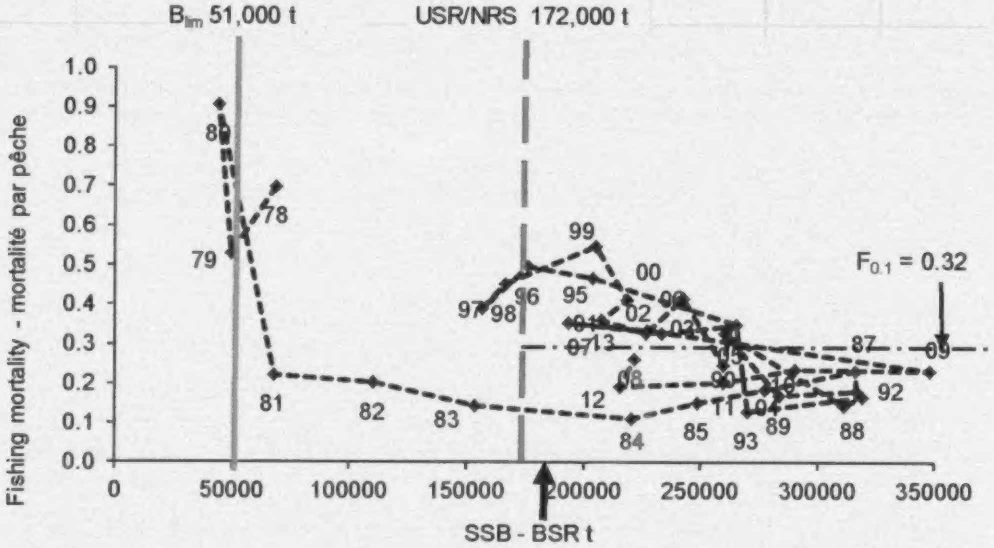


Figure 60. MODEL 2: SPLIT CPUE Fall spawning herring spawning stock biomass and exploitation rate trajectories, 1978 to 2013, relative to the reference points. Arrow indicates the 2014 SSB estimate.

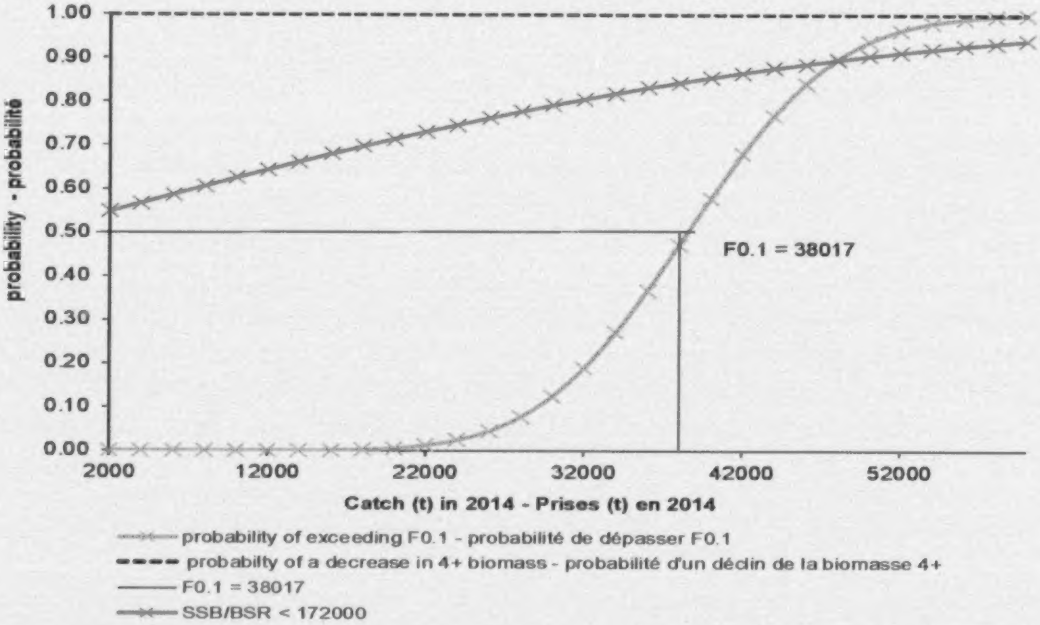


Figure 61. MODEL 2: SPLIT CPUE Risk analyses of catch options in 2014 for fall spawning herring using parameters for ages 4 to 11+.

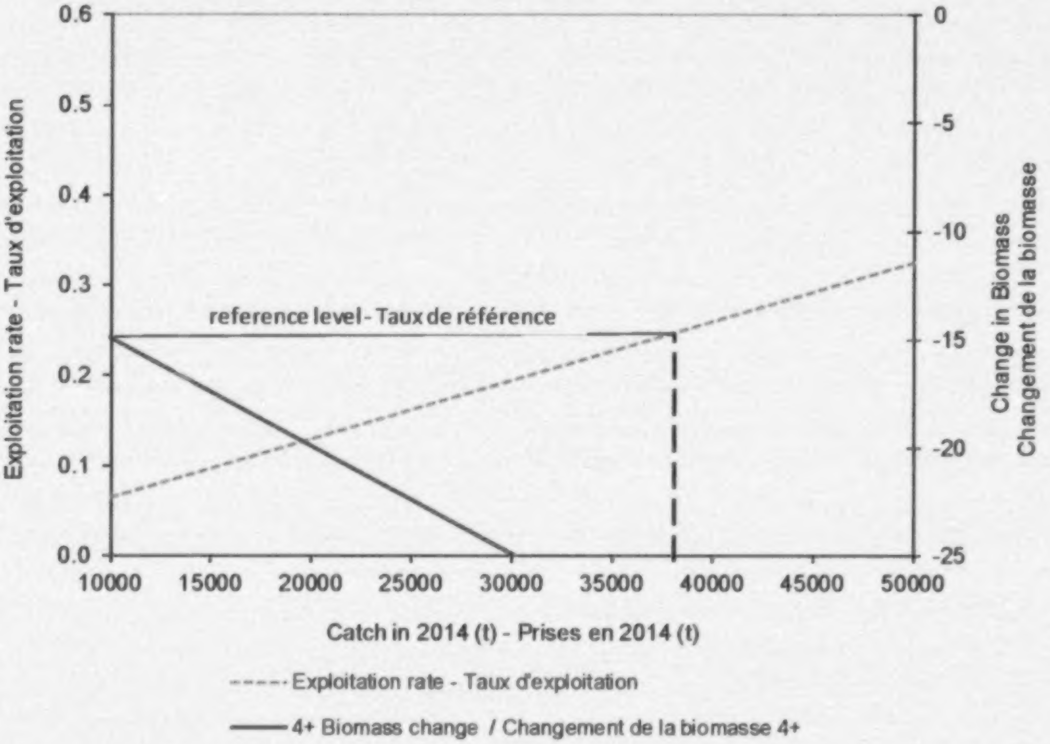
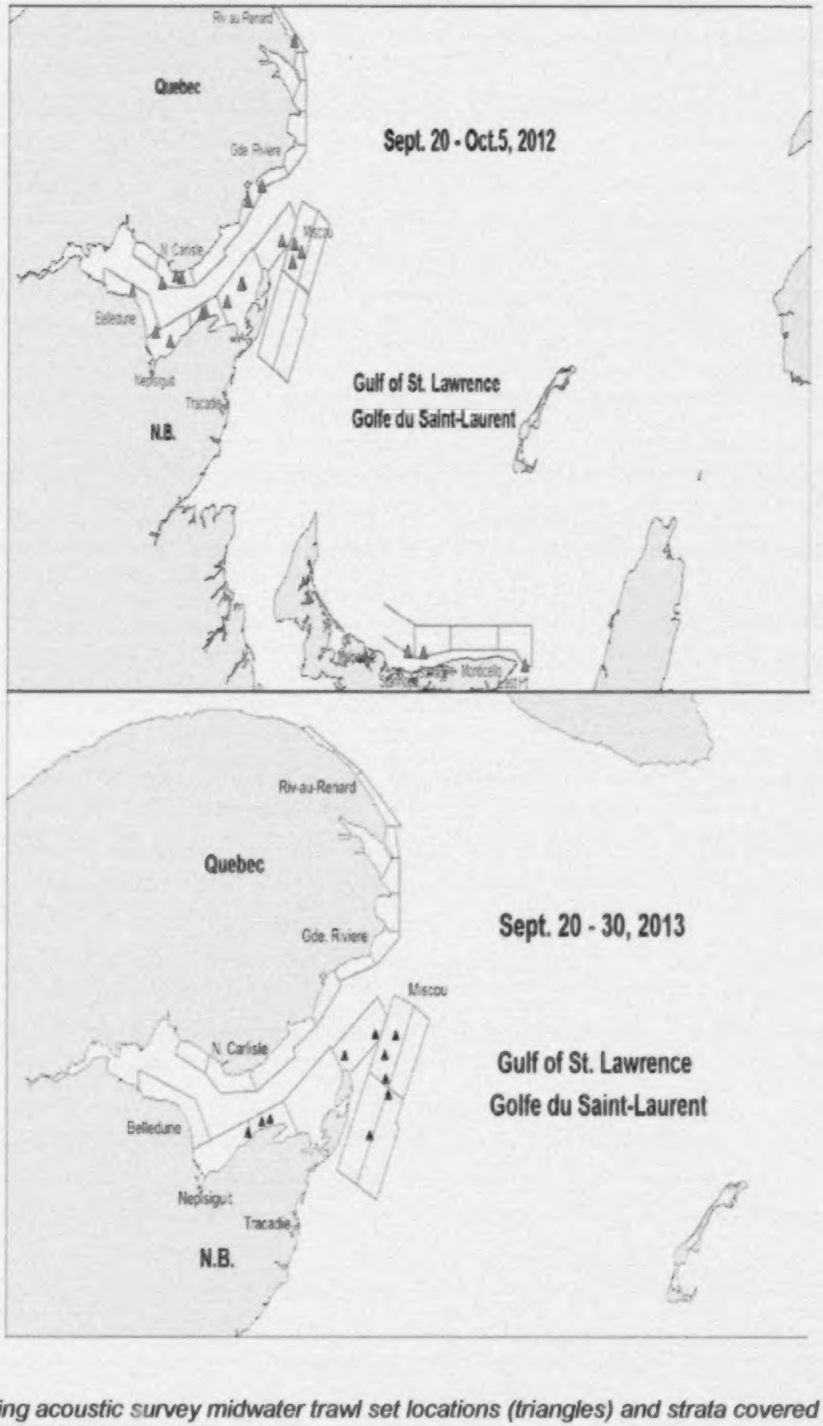


Figure 62. MODEL 2: SPLIT CPUE Exploitation rate and change in biomass for various levels of catch for fall spawning herring. Exploitation rate reference level catch in 2014 is 38,017 t.

APPENDICES


Riv au Renard
Quebec
Gde Riviere
Sept. 20 - Oct.5, 2012
Miscou
N. Carlisle
Belledune
Nepisiguit
Tracadie
N.B.
Gulf of St. Lawrence
Golfe du Saint-Laurent
Riv-au-Renard
Quebec
Gde. Riviere
Sept. 20 - 30, 2013
Miscou
N. Carlisle
Gulf of St. Lawrence
Golfe du Saint-Laurent
Belledune
Nepisigut
Tracadie
N.B.

Appendix 1. Herring acoustic survey midwater trawl set locations (triangles) and strata covered (boxes) in 2012 (upper panel) and 2013 (lower panel).

Appendix 2. Herring acoustic survey fishing set information and main species caught, by mean length (cm) and estimated weight caught (kg) in 2012 and 2013.

Month	Day	Set	Sample	NAFO area	Depth (m)	Duration (min)	Latitude	Longitude	Herring		Mackerel		Gaspereau		Capelin		Cod		While hake		Longhorn sculpin		Sand lance	
									cm	kg	cm	kg	cm	kg	cm	kg	cm	kg	cm	kg	cm	kg	cm	kg
2012																								
9	21	2	84	4TN	36	15	482087	643273	29.2	20	29.0	3	24.0	1	10.9	0.5	5.1	0.2	-	-	-	-	-	-
9	22	3	85	4TN	43	51	481743	644070	16.9	4	-	-	-	-	12.0	1	65.0	12	5.5	0.2	15.8	6.8	-	-
9	22	4	86	4TM	21	16	475931	652400	25.6	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	22	5	87	4TM	27	20	475909	652068	25.6	6900	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	23	6	88	4TM	34	11	475784	653262	25.2	170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	23	7	89	4TM	25	16	475600	654998	24.4	300	19.9	8	6.5	1	9.7	0.1	-	-	-	-	-	-	-	-
9	24	8	90	4TM	30	13	474659	653630	25.1	300	21.2	5	26.8	5	-	-	-	-	-	-	-	-	-	-
9	24	9	91	4TM	28	10	474427	652741	26.3	300	30.8	0.5	-	-	9.0	0.2	-	-	-	-	-	-	-	-
9	24	10	92	4TM	30	15	475122	650637	27.9	500	23.2	5	-	-	-	-	-	-	-	-	-	-	-	-
9	24	11	93	4TM	28	7	475072	650825	28.0	30	21.0	3	-	-	10.8	0.1	55.0	2	9.8	0.1	-	-	-	-
9	25	12	94	4TM	33	8	475359	645314	27.5	800		-	-	-	-	-	-	-	-	-	-	-	-	-
9	25	13	95	4TN	32	15	475803	644425	25.2	75	30.6	4	-	-	-	-	-	-	-	-	-	-	-	-
9	25	14	96	4TN	31	19	475770	644518	25.1	70		-	-	-	-	-	-	-	-	-	-	-	-	-
9	28	15	97	4TN	32	17	480794	642039	25.7	30	28.9	13	-	-	-	-	8.8	0.1	-	-	-	-	11.0	0.1
9	28	16	98	4TN	31	32	480717	641288	26.4	5	27.2	1.5	-	-	-	-	-	-	-	-	-	-	12.0	0.1
9	29	17	99	4TN	37	14	480534	640877	26.6	50		-	-	-	-	-	-	-	-	-	-	-	-	-
9	29	18	100	4TN	29	14	480294	641397	26.0	300	30.0	5	-	-	-	-	-	-	-	-	-	-	-	-
10	2	19	101	4TG	34	18	462659	615361	24.4	1	27.8	0.5	-	-	-	-	-	-	-	-	-	-	-	-
10	4	20	102	4TJ	35	11	462975	625459	20.8	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	4	21	103	4TG	34	8	462985	630391	26.9	450	22.0	4	-	-	-	-	6.8	0.1	-	-	-	-	-	-
2013																								
9	22	1	77	4TM	32.2	15	475136	650609	27.4	159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	22	2	78	4TM	41.6	8	475069	650980	27.5	227	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	22	3	79	4TM	36.5	13	474855	651641	27.8	227	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	27	4	80	4TN	39.8	15	480860	640755	30.0	1	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-
9	28	5	81	4TN	29.5	13	480464	641278	26.2	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	28	6	82	4TN	39.4	19	474791	641967	27.3	30	-	-	5.8	0.2	-	-	-	-	20.6	0.3	18.3	0.3	-	0.01
9	29	7	83	4TN	37.1	23	475629	641099	26.7	10	31.0	0.5	-	-	-	-	-	-	-	-	-	-	-	-
9	29	8	84	4TN	28.3	5	475977	641235	26.8	20	-	-	-	-	10.4	0.1	-	-	-	-	-	-	-	-
9	29	9	85	4TN	38.4	16	480901	641722	27.5	450	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	30	10	86	4TN	40.2	15	480448	643145	25.6	520	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3a. Summary of fall herring acoustic survey including number of transects completed, mean density (kg/m^2), estimated herring biomass (t), and coefficient of variation (CV) in the southern Gulf of St. Lawrence, 2000 to 2013.

Date	Area	Transects	kg/m^2	Tons	CV
2013 Sept. 20 - 30	CHALEURS-MISCOU	158	0.022	75,531	0.17
2012 Sept. 20 - 30	CHALEURS-MISCOU	147	0.030	87,386	0.15
Oct. 1 - 5	P.E.I.	20	0.013	14,140	0.39
2011 Sept. 22 - Oct. 3	CHALEURS-MISCOU	155	0.019	54,236	0.12
2010 Sept. 21 - Oct. 3	CHALEURS-MISCOU	148	0.019	66,245	0.14
Oct. 4 - 7	P.E.I.	31	0.040	79,565	0.36
2009 Sept. 23 - 27	P.E.I.	34	0.007	13,122	0.19
Sept. 28 - Oct. 7	CHALEURS-MISCOU	120	0.015	52,009	0.20
2008 Sept. 23 - Oct. 7	CHALEURS-MISCOU	173	0.010	46,297	0.16
Oct. 8 - 10	P.E.I.	21	0.012	23,785	0.58
2007 Sept. 22 - Oct. 2	CHALEURS-MISCOU	140	0.013	58,401	0.24
Oct. 4 - 11	P.E.I.	44	0.017	39,204	0.25
2006 Sept. 23 - Oct. 3	CHALEURS-MISCOU	145	0.018	73,673	0.19
Oct. 5 - 9	P.E.I.	37	0.045	147,824	0.21
2005 Sept. 22 - Oct. 3	CHALEURS-MISCOU	180	0.019	94,579	0.09
Oct. 4 - 10	P.E.I.	31	0.033	78,467	0.60
2004 Sept. 23 - Oct. 2	CHALEURS-MISCOU	170	0.011	47,970	0.12
Oct. 3 - 9	P.E.I.	34	0.016	176,035	0.17
2003 Sept. 24 - Oct. 6	CHALEURS-MISCOU	168	0.027	127,460	0.21
Oct. 7 - 12	P.E.I.	47	0.054	176,035	0.14
2002 Oct. 2 – 13	CHALEURS-MISCOU	112	0.016	72,085	0.22
Oct. 13	P.E.I.	25	0.027	42,213	0.18
2001 Sept. 28 - Oct. 14	CHALEURS-MISCOU	146	0.010	52,203	0.12
	P.E.I.*	29	0.017	32,392	0.16
Nov. 11 - 13	CAPE BRETON INSHORE	30	0.076	72,712	0.23
2000 Sept. 14 - Oct. 05	CHALEURS-MISCOU	136	0.022	123,671	0.29
	P.E.I.	38	0.023	64,696	0.59
	CAPE BRETON INSHORE	0	-	-	-

* herring and mackerel mixed, no samples estimated from 2000 size

Appendix 3b. Herring biomass densities and estimates by stratum and area from the acoustic survey conducted between September 20 to October 5, 2012.

Area and stratum	Mean TS (dB/kg)	Stratum area (km²)	Weighted mean Sa (dB/m²)	Biomass density (kg/m²)	Biomass total (tons)	Std. error (tons)	Std. error % of total
Gaspe							
Riviere_au_renard	-34.04	124.6	-52.517	0.014194	1768.6	642	36
Cap_bon_ami	-34.04	69	-64.960	0.000809	55.8	51	91
Malbaie	-34.04	95.6	-54.694	0.008599	822.1	668	81
Anse_beaufils	-34.04	96	-1027.297	0.000000	0	0	13
Gaspe total		385.2			2646.5	-	-
Mean density				0.005901	-	-	-
CV of biomass estimate					0.351	-	-
Chaeur-Miscou (same strata)							
Gde_riviere	-34.04	106.4	-60.091	0.002481	264.0	147	55
Newport	-34.04	124.9	-55.287	0.007501	936.9	554	59
Shigawake	-34.04	265.6	-54.095	0.009871	2621.6	872	33
Newcarlisle	-34.52	169	-47.356	0.052031	8793.2	2740	31
Newrichmond	-34.52	111.6	-50.086	0.027750	3096.9	385	12
Belledune	-34.33	266	-46.654	0.058627	15594.6	4327	28
Nepisiguit	-34.67	211.3	-47.931	0.047214	9976.2	2667	27
Maisonnette	-35.25	145	-49.118	0.041054	5952.8	703	12
West_miscou	-34.61	330.5	-51.068	0.022623	7477.0	1959	26
North_miscou	-34.79	295.7	-51.531	0.021158	6256.3	3284	52
Miscou_nw	-34.79	444	-49.013	0.037786	16776.8	10014	60
Miscou_ne	-34.79	352.8	-62.353	0.001751	617.7	411	67
Miscou_sw	-34.79	552.2	-54.162	0.011545	6375.3	410	6
Chaleur-Miscou total		3375.0			84739.3	-	-
Mean density				0.026261		-	-
CV of biomass estimate					0.145	-	-
PEI							
East_point	-34.6	276.5	-49.178	0.034868	9641.1	5441	56
Monticello	-34.6	292.0	-65.128	0.000886	258.7	17	6
Savage_harbour	-34.6	180.0	-56.307	0.006754	1215.7	100	8
Stanhope	-34.6	385.5	-55.656	0.007847	3024.8	417	14
PEI total		1134.0			14140.3	-	-
Mean density				0.012589	-	-	-
CV of biomass estimate					0.386	-	-

Appendix 3c. Herring biomass densities and estimates by stratum and area from the acoustic survey conducted between September 20 to 30, 2013.

Area and stratum	Mean TS (dB/kg)	Stratum area (km^2)	Weighted mean Sa (dB/m^2)	Biomass density (kg/m^2)	Biomass total (tons)	Std. error (tons)	Std. error % of total
Gaspe							
Riviere_au_renard	-34.86	124.6	-55.473	0.008692	1083.0	498	46
Cap_bon_ami	-34.86	69	-76.419	0.000070	4.8	5	110
Malbaie	-34.86	95.6	-65.193	0.000927	88.6	41	47
Anse_beaufils	-34.86	96	-72.907	0.000157	15.1	6	39
Gaspe total		385.2			1191.5	-	-
Mean density				0.002462	-	-	-
CV of biomass estimate					0.419	-	-
Chaeur-Miscou (same strata)							
Gde_riviere	-34.86	106.4	-52.869	0.015829	1684.2	721	43
Newport	-34.86	124.9	-55.322	0.008999	1123.9	699	62
Shigawake	-34.86	265.6	-52.544	0.017061	4531.5	1329	29
Newcarlisle	-35.22	169	-50.603	0.028981	4897.7	2392	49
Newrichmond	-35.22	111.6	-58.275	0.004954	552.8	151	27
Belledune	-35.22	266	-52.752	0.017669	4699.9	2433	52
Nepisiguit	-35.22	211.3	-50.043	0.032973	6967.2	2433	35
Maisonnette	-35.04	145	-45.676	0.086356	12521.7	2229	18
West_miscou	-34.86	330.5	-53.249	0.014505	4793.9	1397	29
North_miscou	-34.86	295.7	-55.846	0.007976	2358.4	1516	64
Miscou_nw	-34.99	444	-47.895	0.051201	22733.2	11070	49
Miscou_ne	-34.99	352.8	-58.695	0.004260	1502.8	565	38
Miscou_sw	-34.99	552.2	-56.48	0.007092	3916.4	734	19
Miscou_se	-34.99	521.3	-59.028	0.003945	2056.3	539	26
Chaleur-Miscou total		3896.3			74339.9	-	-
Mean density				0.021557		-	-
CV of biomass estimate					0.166	-	-

Appendix 3d. Transect backscatter and biomass density in the Chaleurs-Miscou area from the acoustic survey conducted from September 20 to 30, 2012.

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Mean Sa (dB/m^2)	Biomass density (kg/m^2)	Set Number
Riviere_au_renard	C612501H	3.3	-34.04	-48.16	0.039	-
	C612502H	3.5	-34.04	-53.63	0.011	-
	C612503H	3.7	-34.04	-48.69	0.034	-
	C612504H	3.3	-34.04	-54.82	0.008	-
	C612505H	2.9	-34.04	-57.30	0.005	-
	C612506H	2.9	-34.04	-55.36	0.007	-
	C612507H	2.5	-34.04	-59.41	0.003	-
	C612508H	3.8	-34.04	-64.65	0.001	-
Cap_bon_ami	C612509H	2.6	-34.04	-58.94	0.003	-
	C612510H	3.0	-34.04	-66.73	0.001	-
	C612511H	5.1	-34.04	-1027.11	0.000	-
	C612512H	3.8	-34.04	-67.69	0.000	-
Malbaie	C612513H	9.8	-34.04	-1029.89	0.000	-
	C612514H	11.0	-34.04	-49.57	0.028	-
	C612515H	8.3	-34.04	-1029.17	0.000	-
	C612516H	6.8	-34.04	-1028.32	0.000	-
Anse_beaufils	C612517H	6.9	-34.04	-1028.42	0.000	-
	C612518H	5.7	-34.04	-1027.56	0.000	-
	C612519H	5.0	-34.04	-1026.95	0.000	-
	C612520H	3.9	-34.04	-1025.86	0.000	-
Grande_riviere	C612521H	4.1	-34.04	-1026.09	0.000	-
	C612522H	5.0	-34.04	-1026.96	0.000	-
	C612523H	5.6	-34.04	-73.15	0.000	-
	C612524H	5.6	-34.04	-56.83	0.005	1
	C612525H	5.2	-34.04	-62.82	0.001	-
	C612526H	5.0	-34.04	-62.81	0.001	-
	C612527H	3.5	-34.04	-61.11	0.002	-
	C612528H	3.8	-34.04	-53.51	0.011	-
Newport	C612529H	4.4	-34.04	-65.40	0.001	-
	C612530H	5.7	-34.04	-50.17	0.024	2
	C612531H	7.1	-34.04	-60.07	0.002	-
	C612532H	6.7	-34.04	-1028.29	0.000	-
	C612533H	6.5	-34.04	-61.39	0.002	-
	C612534H	6.0	-34.04	-59.98	0.003	-
	C612535H	5.8	-34.04	-48.42	0.036	-
	C612536H	5.7	-34.04	-1027.59	0.000	-
	C612537H	4.9	-34.04	-1026.91	0.000	-
Shigawake	C612538H	4.6	-34.04	-49.35	0.029	-
	C612539H	5.0	-34.04	-54.69	0.009	–
	C612540H	5.0	-34.04	-60.06	0.003	-
	C612541H	5.0	-34.04	-52.55	0.014	-
	C612542H	7.0	-34.04	-48.55	0.035	-
	C612543H	6.1	-34.04	-64.26	0.001	-
	C612544H	5.1	-34.04	-50.88	0.021	-
	C612545H	7.6	-34.04	-59.56	0.003	-
	C612546H	7.5	-34.04	-50.77	0.021	-
	C612547H	6.2	-34.04	-1027.89	0.000	-

Appendix 3d (continued). Transect backscatter and biomass density in the Chaleurs-Miscou area from the acoustic survey conducted from September 20 to 30, 2012.

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Mean Sa (dB/m^2)	Biomass density (kg/m^2)	Set Number
Shigawake	C612548H	5.3	-34.04	-1027.28	0.000	-
	C612549H	5.8	-34.04	-67.20	0.000	-
	C612550H	4.9	-34.04	-1026.92	0.000	-
	C612551H	6.1	-34.04	-1027.84	0.000	-
Newcarlisle	C612552H	6.5	-34.52	-1028.16	0.000	-
	C612553H	5.5	-34.52	-1027.40	0.000	-
	C612554H	5.4	-34.52	-51.05	0.022	3
	C612555H	5.9	-34.52	-42.91	0.145	4
	C612556H	5.9	-34.52	-44.07	0.111	-
	C612557H	5.1	-34.52	-43.09	0.139	-
	C612558H	5.3	-34.52	-50.50	0.025	-
	C612559H	5.1	-34.52	-54.11	0.011	-
	C612560H	4.9	-34.52	-49.37	0.033	-
	C612561H	4.7	-34.52	-48.14	0.043	5
	C612562H	5.4	-34.52	-48.51	0.040	-
Newrichmond	C612563H	5.5	-34.52	-48.88	0.037	-
	C612564H	5.4	-34.52	-48.07	0.044	-
	C612565H	5.5	-34.52	-50.84	0.023	-
	C612566H	5.5	-34.52	-51.08	0.022	-
	C612567H	4.6	-34.52	-51.11	0.022	-
	C612568H	4.6	-34.52	-51.28	0.021	-
	C612569H	4.9	-34.52	-50.93	0.023	-
Belledune	C612570H	5.2	-34.33	-60.03	0.003	-
	C612571H	4.7	-34.33	-67.68	0.000	-
	C612572H	4.5	-34.33	-46.85	0.056	-
	C612573H	4.3	-34.33	-46.47	0.061	-
	C612574H	3.7	-34.33	-46.06	0.067	-
	C612575H	4.5	-34.33	-45.70	0.073	-
	C612576H	4.8	-34.33	-42.91	0.139	-
	C612577H	4.4	-34.33	-41.80	0.179	-
	C612578H	3.8	-34.33	-45.00	0.086	-
	C612579H	4.3	-34.33	-42.89	0.139	-
	C612580H	4.5	-34.33	-41.38	0.198	6
	C612581H	6.3	-34.33	-56.05	0.007	-
	C612582H	7.0	-34.33	-56.37	0.006	-
	C612583H	7.2	-34.33	-56.20	0.007	-
	C612584H	8.4	-34.33	-52.97	0.014	-
	C612585H	6.0	-34.33	-47.83	0.045	-
Nepisiguit	C612586H	10.5	-34.67	-42.07	0.182	7
	C612587H	10.3	-34.67	-51.15	0.023	-
	C612588H	10.2	-34.67	-53.30	0.014	-
	C612589H	9.5	-34.67	-51.40	0.021	-
	C612590H	9.3	-34.67	-51.52	0.021	-
	C612591H	8.6	-34.67	-47.73	0.049	-
	C612593H	7.6	-34.67	-47.16	0.056	8
	C612594H	6.8	-34.67	-48.04	0.046	-
	C612595H	6.4	-34.67	-48.38	0.043	-

Appendix 3d (continued). Transect backscatter and biomass density in the Chaleurs-Miscou area from the acoustic survey conducted from September 20 to 30, 2012.

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Mean Sa (dB/m²)	Biomass density (kg/m²)	Set Number
Nepisiguit	C612596H	6.7	-34.67	-78.10	0.000	-
	C612597H	6.7	-34.67	-1028.27	0.000	-
	C612598H	6.2	-34.67	-47.56	0.051	-
	C612599H	5.9	-34.67	-44.58	0.102	-
Maisonnette	C612600H	5.2	-35.25	-48.44	0.048	-
	C612601H	4.9	-35.25	-51.11	0.026	-
	C612602H	5.3	-35.25	-48.81	0.044	9
	C612603H	5.1	-35.25	-51.15	0.026	-
	C612604H	5.1	-35.25	-48.92	0.043	-
	C612605H	4.9	-35.25	-46.92	0.068	10
	C612606H	5.6	-35.25	-48.01	0.053	-
	C612607H	6.0	-35.25	-48.02	0.053	-
	C612608H	6.2	-35.25	-48.73	0.045	-
	C612609H	3.5	-35.25	-52.95	0.017	-
West_miscou	C612610H	8.7	-34.61	-59.56	0.003	-
	C612611H	8.9	-34.61	-51.77	0.019	11
	C612612H	10.0	-34.61	-53.59	0.013	-
	C612613H	13.6	-34.61	-48.52	0.041	12
	C612614H	12.3	-34.61	-47.42	0.052	13
	C612615H	8.3	-34.61	-49.27	0.034	-
	C612616H	7.1	-34.61	-49.09	0.036	-
	C612617H	7.9	-34.61	-55.36	0.008	-
	C612618H	8.8	-34.61	-1029.45	0.000	-
	C612619H	8.8	-34.61	-65.12	0.001	-
North_miscou	C612620H	5.2	-34.79	-69.85	0.000	-
	C612621H	10.1	-34.79	-59.19	0.004	-
	C612622H	10.5	-34.79	-57.14	0.006	-
	C612623H	10.8	-34.79	-52.41	0.017	-
	C612624H	10.5	-34.79	-50.82	0.025	-
	C612625H	10.6	-34.79	-45.04	0.094	14
	C612626H	10.7	-34.79	-54.46	0.011	-
	C612627H	10.4	-34.79	-1030.16	0.000	-
Miscou_nw	C612628H	13.2	-34.79	-78.54	0.000	-
	C612631H	13.2	-34.79	-1031.19	0.000	-
	C612632H	13.4	-34.79	-64.35	0.001	-
	C612635H	12.8	-34.79	-1031.08	0.000	-
	C612636H	13.2	-34.79	-76.30	0.000	-
	C612639H	13.0	-34.79	-41.16	0.231	15
	C612640H	12.7	-34.79	-51.54	0.021	-
	C612641H	12.6	-34.79	-46.37	0.069	16
	C612642H	12.8	-34.79	-49.09	0.037	17
	C612645H	12.7	-34.79	-51.63	0.021	-
Miscou_ne	C612629H	9.9	-34.79	-1029.96	0.000	-
	C612630H	9.9	-34.79	-1029.95	0.000	-
	C612633H	10.0	-34.79	-81.57	0.000	-
	C612634H	10.4	-34.79	-1030.16	0.000	-
	C612637H	10.2	-34.79	-1030.08	0.000	-
	C612638H	10.2	-34.79	-1030.10	0.000	-
	C612643H	9.7	-34.79	-55.98	0.008	-
	C612644H	10.1	-34.79	-56.59	0.007	-
	C612644H	10.1	-34.79	-56.59	0.007	-
Miscou_sw	C612646H	12.9	-34.79	-54.45	0.011	-
	C612647H	13.0	-34.79	-53.89	0.012	-

Appendix 3e. Transect backscatter and biomass density in the north P.E.I. area from the acoustic survey conducted from October 1 to 5, 2012.

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Mean Sa (dB/m²)	Biomass density (kg/m²)	Set Number
Eastpoint	C612650H	17.8	-34.60	-49.57	0.032	-
	C612651H	17.7	-34.60	-43.75	0.122	-
	C612652H	11.0	-34.60	-59.31	0.003	-
	C612653H	11.0	-34.60	-1030.40	0.000	-
	C612654H	11.3	-34.60	-65.72	0.001	-
	C612655H	10.8	-34.60	-64.77	0.001	-
Monticello	C612656H	11.4	-34.60	-65.15	0.001	-
	C612657H	11.1	-34.60	-66.55	0.001	-
	C612658H	10.8	-34.60	-64.44	0.001	-
	C612659H	10.9	-34.60	-64.76	0.001	-
	C612660H	10.9	-34.60	-65.34	0.001	-
	C612661H	10.6	-34.60	-64.78	0.001	-
Savage harbour	C612662H	11.6	-34.60	-57.26	0.005	-
	C612663H	12.2	-34.60	-56.78	0.006	-
	C612664H	13.9	-34.60	-55.87	0.007	-
	C612665H	14.4	-34.60	-55.71	0.008	-
Stanhope	C612666H	15.2	-34.60	-55.16	0.009	-
	C612667H	15.5	-34.60	-54.67	0.010	18
	C612668H	15.2	-34.60	-57.76	0.005	-
	C612669H	18.4	-34.60	-55.64	0.008	-

Appendix 3f. Transect backscatter and biomass density in the Chaleurs-Miscou area from the acoustic survey conducted from September 20 to 30, 2013.

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Mean Sa (dB/m²)	Biomass density (kg/m²)	Set Number
Riviere_au_renard	C613501H	3.5	-34.86	-58.00	0.005	-
	C613502H	3.9	-34.86	-63.87	0.001	-
	C613503H	3.7	-34.86	-54.27	0.011	-
	C613504H	3.9	-34.86	-58.54	0.004	-
	C613505H	4.0	-34.86	-59.37	0.004	-
	C613506H	3.0	-34.86	-56.83	0.006	-
	C613507H	4.5	-34.86	-49.40	0.035	-
	C613508H	5.5	-34.86	-66.26	0.001	-
Cap_bon_ami	C613509H	4.2	-34.86	-70.00	0.000	-
	C613510H	6.8	-34.86	-1028.30	0.000	-
	C613511H	3.6	-34.86	-1025.55	0.000	-
	C613512H	3.9	-34.86	-1025.87	0.000	-
Malbaie	C613513H	4.5	-34.86	-62.34	0.002	-
	C613514H	10.5	-34.86	-69.68	0.000	-
	C613515H	10.4	-34.86	-68.88	0.000	-
	C613516H	7.9	-34.86	-62.00	0.002	-
Anse_beaufils	C613517H	7.9	-34.86	-84.52	0.000	-
	C613518H	7.4	-34.86	-70.84	0.000	-
	C613519H	7.0	-34.86	-73.65	0.000	-
	C613520H	5.2	-34.86	-70.43	0.000	-
Grande_riviere	C613611H	3.3	-34.86	-1025.21	0.000	-
	C613612H	3.2	-34.86	-49.62	0.033	-
	C613613H	3.9	-34.86	-48.85	0.040	-
	C613614H	5.1	-34.86	-63.49	0.001	-
	C613615H	4.4	-34.86	-49.76	0.032	-
	C613616H	3.9	-34.86	-55.61	0.008	-
	C613617H	4.3	-34.86	-1026.36	0.000	-
Newport	C613601H	3.0	-34.86	-1024.73	0.000	-
	C613602H	3.8	-34.86	-1025.77	0.000	-
	C613603H	4.0	-34.86	-1026.03	0.000	-
	C613604H	3.3	-34.86	-58.64	0.004	-
	C613605H	2.9	-34.86	-55.31	0.009	-
	C613606H	3.5	-34.86	-47.23	0.058	-
	C613607H	4.6	-34.86	-53.30	0.014	-
	C613608H	6.6	-34.86	-59.87	0.003	-
	C613609H	3.9	-34.86	-1025.86	0.000	-
	C613610H	3.7	-34.86	-56.63	0.007	-
Shigawake	C613582H	7.1	-34.86	-1028.50	0.000	-
	C613583H	6.1	-34.86	-75.94	0.000	-
	C613584H	6.4	-34.86	-77.00	0.000	-
	C613585H	5.7	-34.86	-76.59	0.000	-
	C613586H	5.0	-34.86	-1026.99	0.000	-
	C613587H	5.6	-34.86	-55.84	0.008	-
	C613588H	6.0	-34.86	-51.03	0.024	-
	C613589H	6.2	-34.86	-47.50	0.054	-

Appendix 3f (continued). Transect backscatter and biomass density in the Chaleurs-Miscou area from the acoustic survey conducted from September 20 to 30, 2013.

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Mean Sa (dB/m²)	Biomass density (kg/m²)	Set Number
Shigawake	C613590H	6.5	-34.86	-50.96	0.025	-
	C613591H	7.4	-34.86	-48.65	0.042	-
	C613592H	8.0	-34.86	-50.33	0.028	-
	C613593H	6.9	-34.86	-45.95	0.078	-
	C613594H	6.2	-34.86	-53.13	0.015	-
	C613595H	7.0	-34.86	-53.17	0.015	-
	C613596H	7.2	-34.86	-54.57	0.011	-
	C613597H	5.7	-34.86	-59.33	0.004	-
	C613598H	6.6	-34.86	-83.70	0.000	-
	C613599H	6.5	-34.86	-1028.11	0.000	-
	C613600H	4.1	-34.86	-1026.16	0.000	-
Newcarlisle	C613562H	6.0	-35.22	-81.22	0.000	-
	C613563H	6.2	-35.22	-80.33	0.000	-
	C613564H	4.9	-35.22	-74.36	0.000	-
	C613565H	5.7	-35.22	-67.53	0.001	-
	C613566H	4.5	-35.22	-63.32	0.002	-
	C613567H	6.1	-35.22	-61.89	0.002	-
	C613568H	5.9	-35.22	-55.71	0.009	-
	C613569H	4.8	-35.22	-49.68	0.036	-
	C613570H	6.0	-35.22	-53.36	0.015	-
	C613571H	8.3	-35.22	-42.46	0.189	-
	C613579H	5.1	-35.22	-55.24	0.010	-
	C613580H	4.5	-35.22	-53.17	0.016	-
	C613581H	5.4	-35.22	-53.24	0.016	-
Newrichmond	C613572H	5.2	-35.22	-67.79	0.001	-
	C613573H	4.9	-35.22	-68.96	0.000	-
	C613574H	5.5	-35.22	-57.74	0.006	-
	C613575H	5.2	-35.22	-55.47	0.009	-
	C613576H	5.7	-35.22	-55.72	0.009	-
	C613577H	5.5	-35.22	-58.46	0.005	-
	C613578H	5.6	-35.22	-58.80	0.004	-
Belledune	C613546H	7.3	-35.22	-61.43	0.002	-
	C613547H	7.2	-35.22	-59.64	0.004	-
	C613548H	6.6	-35.22	-66.56	0.001	-
	C613549H	7.1	-35.22	-68.78	0.000	–
	C613550H	6.3	-35.22	-66.37	0.001	-
	C613551H	6.1	-35.22	-65.46	0.001	-
	C613552H	5.8	-35.22	-61.00	0.003	-
	C613553H	5.2	-35.22	-56.22	0.008	-
	C613554H	5.1	-35.22	-60.60	0.003	-
	C613555H	4.2	-35.22	-53.29	0.016	-
	C613556H	5.0	-35.22	-43.94	0.135	-
	C613557H	4.7	-35.22	-46.33	0.077	-
	C613558H	4.3	-35.22	-48.85	0.043	-
	C613559H	5.6	-35.22	-54.38	0.012	-
	C613560H	4.0	-35.22	-55.25	0.010	-
	C613561H	4.3	-35.22	-55.54	0.009	-

Appendix 3f (continued). Transect backscatter and biomass density in the Chaleurs-Miscou area from the acoustic survey conducted from September 20 to 30, 2013.

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Mean Sa (dB/m^2)	Biomass density (kg/m^2)	Set Number
Nepisiguit	C613534H	6.0	-35.22	-45.50	0.094	-
	C613535H	6.2	-35.22	-47.01	0.066	-
	C613536H	6.6	-35.22	-46.60	0.073	-
	C613537H	6.5	-35.22	-44.65	0.114	3
	C613538H	6.0	-35.22	-48.59	0.046	-
	C613539H	6.9	-35.22	-53.32	0.016	-
	C613540H	7.8	-35.22	-53.34	0.015	-
	C613541H	8.3	-35.22	-54.47	0.012	-
	C613542H	8.1	-35.22	-57.49	0.006	-
	C613543H	8.7	-35.22	-61.23	0.003	-
	C613544H	8.4	-35.22	-61.64	0.002	-
	C613545H	9.1	-35.22	-60.14	0.003	-
Maisonnette	C613524H	6.7	-35.04	-45.49	0.090	-
	C613525H	6.5	-35.04	-47.55	0.056	-
	C613526H	5.8	-35.04	-46.39	0.073	-
	C613527H	5.9	-35.04	-49.71	0.034	-
	C613528H	5.2	-35.04	-42.34	0.186	2
	C613529H	5.5	-35.04	-45.64	0.087	-
	C613530H	5.0	-35.04	-45.42	0.092	-
	C613531H	4.6	-35.04	-45.72	0.086	-
	C613532H	4.9	-35.04	-43.29	0.150	1
	C613533H	5.1	-35.04	-50.67	0.027	-
West_miscou	C613521H	12.5	-34.86	-58.25	0.005	-
	C613522H	8.3	-34.86	-59.66	0.003	-
	C613523H	8.1	-34.86	-60.42	0.003	-
	C613652H	8.1	-34.86	-49.34	0.036	-
	C613653H	8.1	-34.86	-50.52	0.027	-
	C613654H	7.3	-34.86	-54.83	0.010	-
	C613655H	6.5	-34.86	-54.90	0.010	-
	C613656H	9.1	-34.86	-65.18	0.001	-
	C613657H	10.0	-34.86	-53.60	0.013	-
	C613658H	11.6	-34.86	-49.45	0.035	-
North_miscou	C613644H	9.0	-34.86	-1029.55	0.000	-
	C613645H	10.3	-34.86	-87.58	0.000	-
	C613646H	10.4	-34.86	-50.03	0.030	9
	C613647H	9.2	-34.86	-57.86	0.005	-
	C613648H	10.9	-34.86	-68.35	0.000	-
	C613649H	10.4	-34.86	-59.85	0.003	-
	C613650H	10.2	-34.86	-60.98	0.002	-
	C613651H	5.0	-34.86	-49.40	0.035	10
Miscou_nw	C613618H	12.8	-34.99	-53.36	0.015	-
	C613621H	12.3	-34.99	-1030.88	0.000	-
	C613622H	12.2	-34.99	-51.73	0.021	-
	C613625H	12.2	-34.99	-50.26	0.030	4
	C613626H	12.8	-34.99	-51.48	0.022	-
	C613627H	12.5	-34.99	-53.37	0.015	5
	C613628H	12.9	-34.99	-43.05	0.156	-
	C613631H	12.7	-34.99	-61.91	0.002	-
	C613643H	11.8	-34.99	-41.86	0.206	8

Appendix 3f (continued). Transect backscatter and biomass density in the Chaleurs-Miscou area from the acoustic survey conducted from September 20 to 30, 2013.

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Mean Sa (dB/m²)	Biomass density (kg/m²)	Set Number
Miscou_ne	C613619H	10.5	-34.99	-1030.19	0.000	-
	C613620H	10.2	-34.99	-1030.07	0.000	-
	C613623H	10.9	-34.99	-1030.38	0.000	-
	C613624H	10.4	-34.99	-57.49	0.006	-
	C613629H	10.5	-34.99	-56.11	0.008	-
	C613630H	10.1	-34.99	-54.96	0.010	-
	C613642H	10.5	-34.99	-56.76	0.007	-
Miscou_sw	C613632H	16.7	-34.99	-55.95	0.008	6
	C613635H	12.3	-34.99	-55.23	0.009	-
	C613636H	12.0	-34.99	-56.04	0.008	-
	C613639H	11.9	-34.99	-55.81	0.008	-
	C613640H	13.1	-34.99	-62.18	0.002	-
Miscou_se	C613633H	18.8	-34.99	-56.50	0.007	7
	C613634H	13.3	-34.99	-58.37	0.005	-
	C613637H	13.8	-34.99	-61.50	0.002	-
	C613638H	11.2	-34.99	-64.00	0.001	-
	C613641H	9.9	-34.99	-60.88	0.003	-